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Accessible Pedestrian Signals:

A Curriculum Development Project

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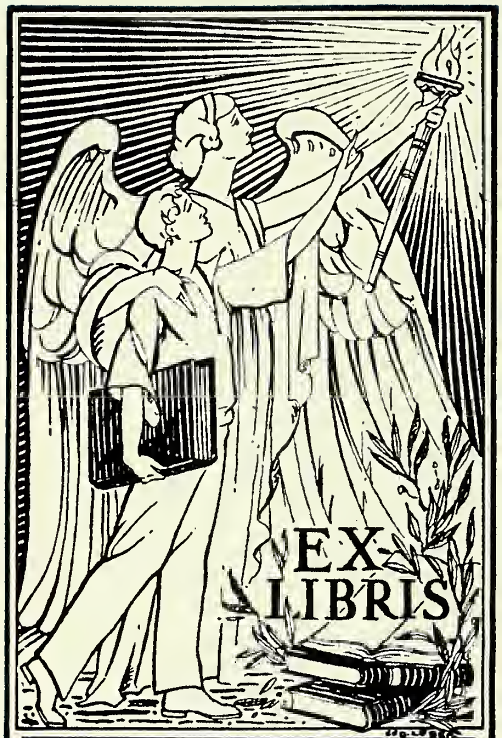

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HOUSE FOR THE BLIND

Eileen Siffermann

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Module 1

History and Current Activities Related to Accessible Pedestrian Environment

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History and Current Activities Related to the Accessible Pedestrian Environment

Objectives

Participants will gain an understanding of:

1. Value of APS to all pedestrians
2. Significant historical events related to accessible pedestrian rights-of-way including:
   - ADA, Title II
   - Access Board
   - PROWAAC and its role
   - MUTCD
   - Transportation Equity Act for the 21st Century
3. Current activities related to APS including:
   - Legislation and enforcement
   - Key government agencies and their roles
4. Consumer groups and their positions on APS
5. Professional membership organizations
6. Certification and/or licensure requirements for:
   - Orientation and Mobility Specialists
   - Dog Guide instructors
   - Travel Instructors
   - Professional Engineers
   - Professional Traffic Operations Engineers
   - Signal Technicians

Introduction

Introduction

Pedestrians who are blind or visually impaired can and do cross many streets at signalized intersections safely and independently. They predominantly use traffic sounds and other auditory cues to determine when to cross.

Some intersection geometries, acoustic conditions, and traffic control systems make it very difficult for persons with visual impairments to detect the WALK interval.

APS devices make visible information about the status of the signal phases available to pedestrians with visual disabilities, enabling them to cross streets independently

- with greater confidence; and
- in a more timely fashion. (Bentzen & Tabor, 1998)

APS terms

In this curriculum APS refers to Accessible Pedestrian Signal(s). Other words used to describe these devices are:

- Acoustic signals
- Audio-tactile signals
- Audible crossing indicators
- Audible pedestrian signals
- Audible traffic signals

Introduction

Project Philosophy

Regulations and guidelines do not address:

- Decisions about where to place an APS
- Which features are appropriate in certain situations
- How to prioritize intersections to be retrofitted with APS

These decisions affect the usability and safety of the APS devices.

More information about APS is needed by:

- Traffic engineers
- Transportation planners
- Signal Technicians
- Orientation and Mobility (O&M) Specialists
- Dog Guide Instructors
- Travel Instructors
- Pedestrians with disabilities

As well, all need a better understanding of each other's concerns and needs in order to make good decisions. This workshop and curriculum is intended to

- provide information to all groups; and
- foster productive working relationships amongst these groups

Accessible Pedestrian Signals (APS)

Brief description of APS

All APS give an auditory (tone or speech) and/or vibrotactile indication of the WALK interval. There are 4 different types of APS, including

PedHead Mounted:

- Most common type in the U.S.
- Speaker mounted on top of the pedestrian signal (pedhead)
- Bell, buzzer, chuckoo, chirp, tone, or speech message during the WALK phase of the cycle only
- Usually intended to be heard across the street and act as a beacon, thus are relatively loud

Pushbutton integrated:

- Speaker and vibrating surface at the pushbutton
- Common in Europe and Australia for years
- Constant quiet locator tone tells about the presence of the pushbutton and its location
- Respond to ambient sound
- Loud enough to be heard only at beginning of crosswalk
- May give other information about name of streets or shape of intersection

Vibrotactile:

- Vibration only (arrow or button vibrates) when WALK signal is on
- Must be installed at curb near crosswalk, so user's hand can be held on button while waiting to cross

Receiver based:

- Message transmitted by infrared or LED technology from the pedestrian signal to a personal individual receiver
- May give other information about name of streets or shape of intersection

Video

Depicts person with visual impairment making 2 street crossings with APS, one with a pedhead mounted device, the second with a pushbutton integrated device.

Accessible Pedestrian Signals (APS)

Value of APS

Accessible Pedestrian Signals:

- Provide audible and/or vibrotactile information coinciding with visual pedestrian signals
- Let pedestrians who are blind know when the WALK interval begins
- May help pedestrians who are blind find mid-block or unusually located crosswalks if a locator tone is part of the device
- May increase safety of persons with cognitive disabilities (who cannot read the pedestrian signals or who function best with audible input)
- May contribute to reduction in pedestrian-vehicular conflicts
- May cause drivers to may pay more attention to pedestrians (at crossings with APS)
- Increase speed at which most pedestrians initiate crossings, increasing operating efficiency, thereby decreasing necessary length of pedestrian interval (widely believed in European countries and Australia)
- Help senior citizens with diminished sight
- Help tourists or persons who are unfamiliar with an intersection

Accessible Pedestrian Signals (APS)

Value of knowledge of APS

For engineers:

Knowledge of installation criteria, equipment features and needs of persons with disabilities:

- Promotes greater standardization in APS placement and understanding of directional requirements, which insures better usability
- Helps with selection of best device for particular crossing
- May lessen public and transportation industry resistance to implementation, arising out of misconceptions based on outdated devices

For O&M Specialists & Dog Guide Instructors & Travel Instructors:

Knowledge of technical aspects of APS:

- Allows for better advice to users and engineers
- Promotes greater understanding of installation challenges and issues

For pedestrians with disabilities:

Knowledge of regulations and device features:

- Promotes better understanding of device usage, which in turn, may increase safety
- Helps with device selection for particular crossing(s)

For more information

Barlow, J.M., Bentzen, B.L., & Tabor, L.S. (2002). *Accessible pedestrian signals: Synthesis and guide to best practice.* National Cooperative Highway Research Program 3-62.

Americans with Disabilities Act (ADA)

ADA

Public Law 226, the Americans with Disabilities Act (ADA), is a civil rights statute, passed on July 26, 1990. ADA prohibits discrimination against persons with disabilities. Title II applies to public facilities. ADA Draft Guidelines for Public Rights-of-Way were issued on June 17, 2002.

Access Board description

From http://www.access-board.gov/indexes/aboutindex.htm

- Short name for the U.S. Architectural and Transportation Barriers Compliance Board
- Independent federal agency that writes regulations implementing ADA
- About 30 staff members
- Governing board comprised of representatives from Federal departments and public members appointed by the President

Access Board tasks

Access Board is responsible for:

- Developing and maintaining accessibility minimum design guidelines for the built environment, transit vehicles, telecommunications equipment, and for electronic and information technology (The guidelines become standards for new construction and alterations when they are adopted by agencies such as the Department of Transportation and the Department of Justice)
- Providing technical assistance and training on these guidelines and standards
- Enforcing accessibility standards for federally funded facilities

The Access Board has provided substantial education and outreach regarding the application of guidelines for public-rights-of-way (PROW). The Access Board is actively involved with transportation industry organizations and works with the Federal Highway Administration (FHWA) on PROW issues.

ADAAG

ADAAG refers to the Americans with Disabilities Act Accessibility Guidelines. Issued by the Access Board in 1991.

Americans with Disabilities Act (ADA)

Historical events in public rights-of-way rulemaking

1. December 1992 – Access Board published a Notice of Proposed Rule Making (NPRM), proposing to add section 14, Public Rights-of-Way to ADAAG, along with other application sections.

2. June 1994 – Access Board published an interim rule in Federal Register, added Section 14, PROW (and other sections) to ADAAG, sought comments. Many persons, including transportation departments, public works agencies, traffic consultants, and others expressed concerns about Section 14 PROW.

3. January 1998 -- Access Board published final rules but decided to reserve section 14 due to concerns.

4. Access Board embarked upon an outreach plan to educate transportation industry regarding the needs of persons with disabilities and application of guidelines in public rights-of-way including:

- Series of videotapes
- Synthesis on APS
- Accessibility checklist
- Design guide on accessible PROW
- Synthesis on detectable warnings

5. Early 1999 – Access Board reviewed education and outreach program and decided to develop final requirements.

6. May 1999 – Board voted to reinitiate rulemaking in this area by convening a Federal advisory committee, the Public Rights-of-Way Access Advisory Committee (PROWAAC), to develop recommendations for guidelines for public rights-of-way covered by ADA and the Architectural Barriers Act of 1968. See PROWAAC below.

7. January 2001 - PROWAAC recommendations published.

8. June 17, 2002 – Board released draft guidelines on accessible PROW for public comment. Public meeting held on October 8, 2002. Deadline for comments was October 28, 2002.
http://www.access-board.gov/news/prow-release.htm

9. See next steps under PROWAAC heading.

Americans with Disabilities Act (ADA)

For more information

Access Board
1331 F Street, NW
Suite 1000
Washington, D.C. 20004-1111
Voice: (202) 272-0080 or 800-872-2253
TTY: (202) 272-0082 or 800-993-2822
Fax: 202-272-0081
Website: www.access-board.gov
Email: info@access-board.gov

Publications available in text, HTML, and PDF formats.

Public Rights-of-Way Access Advisory Committee (PROWAAC)

Description

Public Rights-of-Way Access Advisory Committee (PROWAAC) was chartered in October 1999 by the U.S. Architectural and Transportation Barriers Compliance Board (Access Board).

Purpose - to provide public guidance preliminary to the writing of regulations to implement ADAAG Title II in the PROW.

The PROWAAC members shared a commitment to the principle that users of all abilities have the right to equal access to public rights-of-way. (Access Board, 2001)

Members

57 committee members represented a broad cross-section of interested parties including:

- Public Works Officials (federal, state, and local) from all over the U.S., as well as a Canadian representative
- Engineers and architects representing the Institute of Transportation Engineers (ITE) and American Institute of Architects
- American Association of State Highway and Transportation Officials (AASHTO), state Department of Transportation (DOTs), city transportation departments, and Federal Highway Administration (FHWA)
- Standard setting organizations from U.S. and Canada
- Representatives knowledgeable on issues related to visual impairment including American Council of the Blind (ACB), Association for Education and Rehabilitation of the Blind and Visually Impaired (AER), Council of Citizens with Low Vision International (CCLVI), National Federation of the Blind (NFB), and The Seeing Eye, Inc.
- Advocates from disability groups including Disability Rights, Education and Defense Fund (DREDF), Paralyzed Veterans of America (PVA), and TASH
- Pedestrian Advocates from America Walks and the Bicycle and Pedestrian Foundation
- Persons with disabilities

Recommendations

Published in *Building a True Community: Final Report of the Public Rights-of-Way Advisory Committee*. A free copy of this report is available from the US Access Board 1-800-USA-ABLE or www.access-board.gov

Public Rights-of-Way Access Advisory Committee (PROWAAC)

Committee process

Reviewed available information related to access in public rights-of-way, such as:

- ADAAG, section 14
- *Accessible Rights-of Way Design Guide* (Access Board)
- FHWA *Designing Sidewalks and Trails for Access*

Examined approaches used by state and local governments to meet access responsibilities in the absence of specific ADAAG guidance.

Discussed pending design documents such as *AASHTO Pedestrian Design Guide.*

Presented final report to Access Board at the Transportation Research Board's (TRB) annual meeting in January 2001.

The next steps

Agencies were encouraged to consider the PROWAAC recommendations as "best practice" until a final rule was adopted.

The Access Board released the Draft Guidelines for Public Rights-of-Way on June 17, 2002 for public comment.

http://www.access-board.gov/news/prow-release.htm

The Draft Guidelines in the area of APS are discussed in detail in Module 4.

After the comment period ends, the Access Board will draft a Notice of Proposed Rule Making (NPRM) expected to be published in 2003, which will contain:

- Proposed regulations including figures
- Series of questions contained in the preamble

Public comment on the NPRM, including a series of public hearings, will be accepted for approximately 6 months.

Access Board prepares a Final Rule based on public comment in 2004.

Public Rights-of-Way Access Advisory Committee (PROWAAC)

Call for research

The PROWAAC report calls for research in the following areas related to APS:

- Localizable tones for the locator tone in the presence of traffic sounds
- Overhead versus pedestrian pushbutton mounted speakers for orientation and alignment purposes (being conducted by the National Institutes of Health)
- Use of tones, speech messages, or alternating signals for localization
- How best to notify pedestrians who are blind or visually impaired of a mid-block crosswalk, via a guidance surface or a pushbutton with a locator tone

Legislation – Transportation Equity Act for the 21st Century (TEA-21)

TEA-21

The Transportation Equity Act for the 21st Century (TEA-21) was signed into law on June 9, 1998.

http://www.fhwa.dot.gov/environment/te_final.htm

This legislation:

- Updates Titles 23 and 49 of the U.S. Code
- Builds on major changes made and programs addressed by 1991 ISTEA
- Includes numerous provisions regarding the implementation of transportation enhancement (TE) activities
- Lists qualifying TE activities, the first being provision of facilities for pedestrians and bicyclists
- Requires that all funded activities must be accessible to the general public

Funds

TEA-21 sets aside federal funds for TE activities.

The federal funds are typically available to state Departments of Transportation (DOTs). These funds can be used for reimbursement of APS (typically at 80%).

APS

Directs that audible traffic signals, where appropriate, be included in pedestrian safety plans and facilities. {Sec. 1202(g)(2)}

Other

Requires that FHWA, in concert with AASHTO and ITE, develop guidance on pedestrian and bicycle design and construction.

For more information

Website http://www.fhwa.dot.gov/tea21. Print copies of *TEA-21: A Summary* can be obtained by calling 1-800-240-5674.

Summary of Accessibility Standards & Guidelines and Enforcement

ADA	Regulations are enforceable only as violations of civil rights. Decisions are made through rulings on court cases and precedents set in previous cases. Complaints of violations are submitted to the Access Board or to the Department of Transportation or the Department of Justice, depending on the situation and the enforcing agency.
ANSI	American National Standards Institute sets consensus standards (technical specifications) for industry. ANSI Committee A117 on Architectural Features and Site Design of Public Buildings and Residential Structures develops and publishes the industry standard, ANSI A117.1, the *American National Standard: Accessible and Usable Buildings and Facilities.* This document is comprised of technical specifications for which scoping (requirements for where technical specifications are to be implemented) is provided by the International Code Council. ANSI A117 standards and associated scoping may be adopted as state and local building codes, which makes them enforceable as the environment is being built. No reference to APS in ANSI standards. The next revision will be completed in 2003 and may adopt the MUTCD standards by reference. The ANSI 117 Committee and the Access Board work at harmonizing ANSI A117 and ADAAG. This is an ongoing process as both are periodically revised and have lengthy public comment periods.
U.S. DOJ	The U.S. Department of Justice (DOJ) regulates state and local governments' compliance with ADAAG or the Uniform Federal Accessibility Standards (UFAS) for newly constructed or altered facilities. The DOJ has rulemaking authority and enforcement responsibility for ADA, Title II.
U.S. DOT	U.S. Department of Transportation (DOT) implements compliance procedures relating to transportation, including those for highways, streets, and traffic management.

Summary of Accessibility Standards & Guidelines and Enforcement

FHWA	Federal Highway Administration. FHWA Office of Civil Rights oversees the DOT mandates (in above areas). The FHWA is working toward bringing the MUTCD into harmonization with ADAAG.
ISO	International Organization for Standardization. ISO writes voluntary industry standards, through an international consensus process. In November 1999, ISO Working Group 6 completed Committee Draft ISO/CD 1159.2, *Technical aids for blind and vision impaired persons – Acoustic and tactile signs for traffic lights.* This document has standards for locator tones, acoustic signals to indicate WALK interval, and audible beaconing.
UFAS	Uniform Federal Accessibility Standards includes standards for curb ramps. State and local governments can choose to follow UFAS until ADAAG Title II PROW regulations are adopted. These standards are issued under the Architectural Barriers Act (ABA) of 1968.
Language	Common to all standards and guidelines: **Shall** – mandatory provisions **Should** - must be done, unless there are accepted reasons why it is impossible. Reasons vary with the standard or guideline. **May** – permitted features
For more information	ANSI A117 – lbrown@intlcode.org FHWA – www.fhwa.dot.gov ISO – www.iso.ch U.S. DOJ – (202) 514-0301 or (800) 514-0301 U.S. DOT – 400 Seventh St, SW, Washington, DC 20590

Manual on Uniform Traffic Control Devices – MUTCD

Description

The MUTCD is a manual published by the Federal Highway Administration (FHWA). The original edition was published in 1935. It includes guidelines and standards about traffic control devices that are required or permitted.

The National Committee on Uniform Traffic Control Devices (NCUTCD), a committee of over 200 transportation professionals, makes recommendations to FHWA regarding the MUTCD.

The Millennium Edition (MUTCD 2000) was the first edition to include information on APS.

National standards

The MUTCD is

- Incorporated by reference in 23 Code of Federal Regulations (CFR), Part 655, Subpart F
- The National standard for traffic control devices on any street, highway, or bikeway open to public travel

All States must:

- Conform with the MUTCD standards when installing all traffic control devices
- Adopt any changes that FHWA makes to MUTCD within 2 years, unless otherwise noted in the Final Rule

Violating the MUTCD may have legal consequences.

Text headings

Language conventions utilized in the MUTCD:

Standard – required, mandatory, or specifically prohibitive practices regarding a traffic control device. The verb **shall** is used.

Guidance – recommended, but not mandatory, practice in typical situations with deviations allowed if engineering judgement or study indicates deviation to be appropriate. The verb **should** is used.

Option – permissive condition; carries no requirement or recommendation. Allowable modifications to a standard or guidance. The verb **may** is used.

Support – informational statement. Does not convey any degree of mandate, recommendation, prohibition, or enforceable condition.

Manual on Uniform Traffic Control Devices – MUTCD

Regulations	APS provisions in MUTCD are summarized in Module 4.
For more information	MUTCD Millennium Edition can be downloaded from the FHWA website, www.fhwa.dot.gov file://D:\resource%20info\Mutcd-small\index.htm Sections on APS are Part 4E.06, Accessible Pedestrian Signals and Part 4E.08, Accessible Pedestrian Signal Detectors

Government Organizations – The Federal Highway Administration (FHWA)

Description

The Federal Highway Administration: (FHWA)

- Part of the US Department of Transportation (DOT)
- Headquartered in Washington, D.C.
- Field offices across the United States

FHWA provides expertise, resources, and information to continually improve the nation's highway system and its intermodal connections.
http://www.fhwa.dot.gov/whoweare/whoare3.htm

Mission

"The vision of the FHWA is to create the best transportation system in the world for the American people through proactive leadership, innovation, and excellence in service. We also provide expertise, resources, and information to continually improve the quality of our nation's highway system and its intermodal connections. We undertake this mission in cooperation with all of our partners to enhance the country's economic vitality, quality of life, and the environment."

www.fhwa.gov/whoweare/whoare7.htm

Government Organizations – The Federal Highway Administration (FHWA)

Structure

To support all of the program areas, FHWA conducts and manages a comprehensive research, development, and technology program. The FHWA performs its mission through these main programs:

Federal-Aid Highway Program provides federal funds to the States to construct and improve:

- National highway system
- Urban and rural roads
- Bridges

Federal Lands Highway Program provides access to and within:

- National forests and national parks
- Indian reservations
- Other public lands

FHWA's Federal Lands Highway Program does this by preparing plans, letting contracts, supervising construction facilities, and conducting bridge inspections and surveys.

FHWA's Crossing-Cutting Program and Support includes the offices:

- Policy
- Corporate Management
- Chief Counsel
- Research, Development, and Technology
- Public Affairs
- Civil Rights
- Professional Development
- Administration

MUTCD

Published by FHWA

Office of Civil Rights

This FHWA office oversees the DOT mandates in the areas of highways, streets, and traffic management.

For more information

Federal Highway Administration

400 7th Street, SW

Washington, D.C. 20590

Website: www.fhwa.dot.gov

Government Organizations – American Association of State Highway and Transportation Officials (AASHTO)

Description	AASHTO is a nonprofit, nonpartisan association representing highway and transportation departments in the 50 states, District of Columbia, and Puerto Rico. It represents all 5 transportation modes: air, highway, public transit, rail, and water.
Members	All members are government officials. • States have a member from the department or agency that has official highway responsibility within that state. • The U.S. DOT is an ex-officio member. Affiliate agencies in the territorial governments of the U.S. and Canadian provinces and Mexican states can attend meetings and committee sessions and take part in discussions, but they have no vote. State, federal and regional associate members cannot vote. AASHTO has a Subcommittee on Traffic Engineering.
Goal	To foster development, operation, and maintenance of an integrated national transportation system.
Mission statement	"AASHTO's mission is to advocate transportation policies, provide technical services, demonstrate the contributions of transportation and facilitate institutional changes." www.aashto.org/aashto/organization.nsf/allpages/mission
Research and publications	Works with FHWA and ITE to develop guidance on pedestrian and bicycle design and construction, including accessibility features. Member departments (state DOTs) sponsor the National Cooperative Highway Research Program, in cooperation with the FHWA. Publishes *A Policy on Geometric Design of Highways and Streets*, which is also known as the "Green Book". Chapter 2 contains a discussion on designing to meet the needs of people with disabilities. The book also contains provisions for sidewalk construction.

Government Organizations – American Association of State Highway and Transportation Officials (AASHTO)

For more information	AASHTO 444 North Capital Street, NW, Suite 225 Washington, D.C. 20001 Phone: (888) 227-4860 Website: www.aashto.org

Government Organizations – State Departments of Transportation (DOT)

Description

Each state has a Department of Transportation (DOT). The mission of the state DOT is to support and improve the safety and mobility of people and goods within the state by providing reliable, safe travel on all modes of transportation within the state.

Duties and purposes

The role and structure of the state DOT may vary somewhat from state to state, often depending upon the population, size and number of urban areas within the state, and state legislation. However, most state DOTs are responsible for:

- Driver licensing and vehicle registration services
- Highway and bridge maintenance, expansion, and restoration
- Bicycle and pedestrian advisory committees
- Construction and maintenance of Welcome centers along state highways
- State Police
- Data collection and analyses of highway traffic statistics
- Determination of how to allocate federal and state resources, including funds set aside for transportation enhancement (TE) activities
- State DOTs are members of AASTHTO. They sponsor the National Cooperative Highway Research Program in cooperation with the FHWA

State Traffic Engineers

Each state has a State Traffic Engineer. Most are members of the AASHTO Subcommittee on Traffic Engineering. State Traffic Engineers work with the sections that control traffic and signal systems. In major cities, they will only provide oversight, as cities have their own traffic engineering staff.

APS

State DOTs can procure federal funds for APS through TEA-21 as APS installations are considered Transportation Enhancement (TE) activities.

Some state DOTs adopt schemes for prioritizing APS retrofits. In other states, these prioritization schemes are developed and used by municipalities.

For more information

Contact each state department of transportation website.

Government Organizations – Transportation Research Board (TRB)

Description

The Transportation Research Board (TRB) is a unit of the National Research Council, a private nonprofit institution that is the principal operating agency of the National Academy of Sciences and the National Academy of Engineering.

State transportation departments, the various administrations of the U.S. DOT and other federal agencies support TRB, as do other organizations and individuals interested in the development of transportation.

Mission Statement

"To promote innovation and progress in transportation by:

- Stimulating and conducting research
- Facilitating the dissemination of information
- Encouraging the implementation of research results."

www4trb.org/trb/homepage.nst/web/about

Research

Conducts special studies on transportation policy issues at the request of U.S. Congress and government agencies.

Administers two contract research programs

- National Cooperative Highway Research Program (NCHRP)
- Transit Cooperative Research Program (TCRP)

NCHRP is sponsored by the member departments of AASHTO, in cooperation with the FHWA. Many key decisions related to signalization have been generated through information gained by TRB research projects.

www4trb.org/crp.nsf/reference/appendices/NCHRP+Overview

Information

TRB provides information to the transportation community:

- Disseminates reports, peer-reviewed technical papers on research findings
- Operates an on-line computerized file of transportation research information
- Hosts an annual meeting that typically attracts 8,000 transportation professionals from the U.S. and abroad

APS research

NCHRP Project 3-62, Guidelines for Accessible Pedestrian Signals. Publication entitled *Accessible Pedestrian Signals: Synthesis and Guide to Best Practice.*

Government Organizations – Transportation Research Board (TRB)

For more information

TRB
500 Fifth Street, NW
Washington, D.C. 20001
Phone: (202) 334-2934
Fax: (202) 334-2003
Website: www.trb.org

Consumer Groups – American Council of the Blind (ACB)

Description

American Council of the Blind (ACB)

Consumer and advocacy membership organization of persons who are blind & visually impaired and others. ACB was founded in 1961.

Members

Membership

- 20,000 active members (October 2002)
- Not limited to blind or visually impaired individuals, many sighted members
- Legal blindness requirement to serve on most Board of Directors positions
- 51 state and regional affiliates
- 20 national special interest and professional affiliates

Purpose

"To improve the well-being of all blind & VI people by:

- Serving as a representative national organization
- Elevating the social, economic, and cultural levels of blind people
- Improving educational and rehabilitation facilities and opportunities
- Cooperating with public and private institutions and organizations
- Encourage and assist all blind persons to develop their abilities
- Conduct public education programs to promote greater understanding of blindness and the capabilities of blind people"

Direct quote from www.acb.org/profile.html

APS position

Long-time advocates for APS

- Participated in PROWAAC as committee member
- Supported all PROWAAC recommendations
- Worked with the National Committee on Uniform Traffic Control Devices (NCUTCD) to develop recommended language regarding APS for the MUTCD

ACB Statement in Support of Accessible Pedestrian Signals, received by Project in July 2002. This statement can be found in Appendix A.

Consumer Groups – American Council of the Blind (ACB)

Other	Conducted a survey of pedestrians who are legally blind regarding their experience crossing at intersections with and without APS. (Carroll & Bentzen, 1999)
For more information	American Council of the Blind 1155 15th Street, NW, Suite 1004 Washington, D.C. 20005 Phone (202) 467-5081 or (800) 424-8666 Fax: (202) 467-5085 Website: www.acb.org

Consumer Groups–National Federation of the Blind (NFB)

Description

National Federation of the Blind (NFB)

Consumer and advocacy membership organization of persons who are blind and their families. NFB was founded in 1940.

Members

Membership

- 50,000 members
- must be blind to be a member
- sighted individuals are allowed to be associate members
- Affiliates in all 50 states plus Washington, D.C. and Puerto Rico
- Over 700 local chapters

Purposes

- "Help blind persons achieve self-confidence and self-respect
- Act as a vehicle for collective self-expression by the blind"

"Strive to educate the public that blind are normal individuals who can compete on terms of equality through providing:

- Public education and literature about blindness
- Information and referral services
- Scholarships
- Aids, appliances and other adaptive equipment for the blind
- Advocacy services and protection of civil rights
- Job Opportunities for the Blind
- Development and evaluation of technology
- Support of blind persons and their families"

Direct quote from www.nfb.org/aboutnfb.htm

APS position

NFB's position is that there is a limited need for APS

- Participated in PROWAAC as committee member
- Agree with many, but not all of PROWAAC recommendations

Recommends that APS MAY be provided but should NOT be required at all locations specified in PROWAAC Reference – Minority Report – *Appendix G of Building a True Community, Final Report, PROWAAC.* A copy of this document can be found in Appendix A.

Consumer Groups–National Federation of the Blind (NFB)

For more information

National Federation of the Blind
1800 Johnston Street
Baltimore, MD 21230
Phone: 410-659-9314
Email: nfb@nfb.org
Website: www.nfb.org

Professional Membership Organizations – Association for Education and Rehabilitation of the Blind and Visually Impaired (AER)

Description

The Association for Education and Rehabilitation of the Blind and Visually Impaired (AER).

AER is an international membership organization dedicated to rendering support and assistance to professionals who work with persons with visual impairments and blindness of all ages in various service delivery settings. The vast majority of AER members are from the United States and Canada.

AER was founded in 1984, as merger of the Association for Workers for the Blind (AAWB) and the Association for Education of the Visually Handicapped (AEVH).

Members

www.aerbvi.org/text_only/general/who_are.htm

Approximately 4,600 members, as of October 2002:

- Orientation and Mobility (O&M) Specialists
- Teachers of the Visually Impaired
- Rehabilitation Teachers
- Low Vision Therapists
- Administrators
- Support personnel

Other members include parents of children with visual impairments, students learning about the field, and companies and organizations that supply products and services to consumers with visual impairments.

AER has:

- 44 regional chapters throughout the United States and Canada
- 17 divisions of interest; promoting professional development in different disciplines, including the Orientation and Mobility (O&M) Division.

Professional Membership Organizations – Association for Education and Rehabilitation of the Blind and Visually Impaired (AER)

Purposes

"Render support and assistance to professionals who work in education and rehabilitation of persons of all ages who are blind or visually impaired through:

- Offering professional development activities at the international, district, and chapter levels – conferences, seminars, journals, newsletters, leadership training
- Advancement of professionalism – encourage university training, high quality standards for individuals and agencies, and adherence to professional codes of ethics and professional certification
- Working to improve and expand services for individuals with visual impairments – encouraging research, advocating for public policies, and providing a forum for discussion of issues related to service delivery."

www.aerbvi.org/text_only/general/bylaws.htm

APS position

In July 1998 AER approved resolutions urging FHWA and Transport Canada to:

- Develop recommended practices for APS installations
- Develop standards for pushbutton location technology

Adopted a resolution in July 2002 urging FHWA and Transport Canada to establish regulations requiring consistent pushbutton location at all intersections requiring pushbutton activation of pedestrian timing.

AER

- Participated in PROWAAC as committee member
- Worked with the National Committee on Uniform Traffic Control Devices (NCUTCD) to develop recommended language regarding APS for the MUTCD

Professional Membership Organizations – Association for Education and Rehabilitation of the Blind and Visually Impaired (AER)

O&M division of AER

Environmental Access Committee (EAC) of the Orientation and Mobility (O&M) Division has regional representatives throughout the United States and Canada. These O&M Specialists network with traffic engineers to strive for effective installations of APS and other accessibility features, where appropriate.

The O&M Division surveyed O&M specialists to identify types of difficulties their students (persons with visual disabilities) have in crossing streets at signalized intersections. (Bentzen, Barlow, and Franck, 2000).

For more information

AERBVI

4600 Duke Street, Suite 430

P.O. Box 22397

Alexandria, VA 22304

Voice: (703) 823-9690 Fax: (703) 823-9695

Website: www.aerbvi.org

Professional Membership Organizations – Institute of Transportation Engineers (ITE)

Description

Institute of Transportation Engineers (ITE).

An international individual member educational and scientific association. One of the largest and fastest growing multimodal professional transportation organizations in the world.

Founded in 1930.

Members

15,000 members working in 80 countries are

- traffic engineers;
- transportation planners; and
- students and others in surface transportation industry.

ITE has more than 70 local and regional chapters and 90 student chapters.

Purposes

"Facilitate application of technology & scientific principles to research, planning, functional design, implementation, operation, policy development, and management for any mode of transportation by:

- Promote professional development of members
- Support and encourage education
- Stimulate research
- Develop public awareness
- Exchange professional information
- Maintain a central point of reference and action."

www.ite.org/aboutite/History.htm

APS position

- No published statement.

Professional Membership Organizations – Institute of Transportation Engineers (ITE)

Traffic engineering council

In 1997, ITE's Traffic Engineering Council formed the Committee on Accessible Intersections for Pedestrians who are Blind or Visually Impaired. Committee includes ITE members and representatives from professional and advocacy organizations in the blindness field.

Committee objectives:

- Identify the characteristics of an accessible intersection
- Produce an electronic toolbox for making intersections more accessible
- Identify research needs for the tools discussed in toolbox to form basis for a future recommended practice

ITE website includes a Toolbox on Accessible Intersections for Persons with Visual Impairments and provides a wealth of resources for accessible intersections including:

- PowerPoint presentation that describes features of APS and summarizes guidelines on pushbutton location and audible beaconing
- Survey report on recommended language for APS speech messages
- *ITE Journal* article regarding problems persons with visual impairments experience at signalized intersections; survey of O&M specialists (Bentzen, Barlow & Franck, 2000)
- Links to Access Board publication on APS, MUTCD, PROWAAC report and other design guides for accessibility

www.ite.org/library/accessibleint.htm

Professional Membership Organizations – Institute of Transportation Engineers (ITE)

Pedestrian and bicycle council

Newly formed council established to represent and promote the needs of pedestrians, bicyclists and other forms of human-powered travel in the planning, design, construction, operation, and maintenance of transportation infrastructure.

This council's goals include:

- "Promote development of comprehensive transportation infrastructure, inclusive of all modes of travel
- Serve as a crosscutting resource between other organizations and agencies on pedestrian and bike issues
- Educate ITE members, agencies, and policy makers on needs of pedestrian and bicycle communities."

www.ite.org/councils/pedandbike.htm

For more information

Institute of Transportation Engineers
1099 14th St., NW, Suite 300 West
Washington, D.C. 20418
Voice: (202) 289-0222
Fax: (202) 289-7722
Website: www.ite.org

Professional Membership Organizations – Association of Pedestrian and Bicycle Professionals (APBP)

Description	Association of Pedestrian and Bicycle Professionals (APBP). Membership organization of professionals, academics, and students who are committed to making bicycling and walking viable transportation options in the U.S. Founded in 1995.
Members	Leaders in the engineering, planning, landscape architecture, safety and promotion fields who specialize in improving conditions for bicycling and walking. Members work for: • Federal, state, regional, and local governments • Consulting firms • Non-profit organizations • The media http://apbp.org/history.htm
Purposes	• Information exchange – sharing ideas and best practices • Promote excellence in emerging field of bike and pedestrian transportation
APS position	No published statement.
Other	• APBP worked to include bicycle & pedestrian provisions in TEA-21 safety program • Published *Improving Conditions for Bicycling and Walking: A Best Practices Report* with Rails-to-Trails Conservancy and FHWA
For more information	APBP P.O. Box 23576 Washington, D.C. 26026 Voice: (202) 366-4071 Fax: (703)-876-0562 Email: pedbike@aol.com Website: http://apbp.org

Professional Membership Organizations – Association of Travel Instruction (ATI)

Description

National professional association, which exists to develop the professions of travel training instructor and travel trainer. These professionals teach people with disabilities (other than persons who are blind or visually impaired) to travel independently.

Founded in 1998 and incorporated in early 2001.

It is the belief of ATI that every person who has a disability should be able to move about without harm and with purpose.

Members

Anyone interested in the accessible transportation field can become a member. Current members include:

- Travel instructors and travel trainers who work for transit properties, school districts, community rehabilitation agencies, and independent living centers
- Parents of children with disabilities
- Orientation and Mobility specialists
- Persons with disabilities who are transportation advocates
- Administrators and support personnel

There are also agency and corporate memberships.

Purpose

“The goal of ATI is to serve the practitioners who teach persons with disabilities to use public transit.” ATI’s objectives include:

- Provide members with current information on the travel instruction profession
- Allow opportunities for professional development through newsletters and conferences
- Educate the public on the emerging field of travel instruction
- Promote essential competencies for those engaged in the practice of travel instruction
- Develop and maintain a Code of Ethics and a Certification process for travel instructors and trainers

Source: ATI brochure, 2002

Professional Membership Organizations – Association of Travel Instruction (ATI)

APS position	No formal statement provided. In general, any type of information that helps persons with disabilities obtain greater independence in community travel is supported by ATI.
Other	Persons have been providing travel instruction to individuals with disabilities (other than blindness) for several decades. Instructors were agency trained, or had degrees in special education, rehabilitation, or related fields. However, the field of Travel Instruction is relatively new. The first university training program started in 1999 and a Code of Ethics and certification procedures were adopted in summer of 2002.
For more information	Association of Travel Instruction Box 2042 Madison Square Garden New York, NY 10159 Phone: (718) 803-3782, ext 278 Fax: (718) 803-1252

Certification - Dog Guide Instructors

Dog guide instructors	Dog guide instructors train dog guides and teach persons who are blind or visually impaired to travel using the dog guides. The dog guide schools provide training for instructors they employ. Apprenticeships are generally 3 years, but are not standardized.
Certification	Dog guide instructors are not certified by any organization or body. In California, there is a Guide Dog Board that issues licenses to instructors who have passed a state test that is both written and practical.
For more information	For more information, contact the individual dog guide school. A list of 14 dog guide schools can be found at the American Foundation for the Blind (AFB)'s website at www.afb.org under Directory of Services, Dog Guide Training.

Certification - Travel Instructors and Travel Trainers

Travel Instructors

Certification in the field of travel instruction is currently being developed. The certification process will be administered by the ATI. There is a great deal of variability in the preparation of travel instructors; however, all have at least a Bachelor's degree. Travel Instructors teach persons with mobility impairments, cognitive disabilities, hearing loss, mental health diagnoses, and multiple disabilities. Travel instructors do NOT teach persons with severe visual impairments or blindness.

Travel trainers have less than a bachelor's degree. They teach portions of the travel instruction program, under the supervision of a Travel Instructor.

Travel instruction is further described in Module 2B.

For more information

For more information

Association of Travel Instructors (ATI)

Box 2042

Madison Square Garden

New York, NY 10159

Phone: (718) 803-3782, ext. 278

Fax: (718) 803-1252

Certification - Orientation & Mobility Specialists

Two certifying bodies

O&M specialists may be certified by one of two entities:

- Academy for Certification of Vision Rehabilitation and Education Professionals (ACVREP)
- National Blindness Professional Certification Board, Inc. (NBPCP)

ACVREP Certified Orientation and Mobility Specialists, COMS

The professional certification of O&M Specialists, which is provided currently by ACVREP, was first established over 30 years ago. Originally, O&M certification was administered through AER, and it's predecessor, The American Association of Workers for the Blind, starting in 1968.

In January 2000, certification of O&M specialists was taken over by the Academy for Certification of Vision Rehabilitation and Education Professionals (ACVREP). ACVREP is an independent and autonomous legal certification body governed by a volunteer Board of Directors. ACVREP offers certification in three disciplines: Low Vision Therapists, O&M Specialists, and Rehabilitation Teachers.
www.acvrep.org/coms_history.html

O&M specialists certified by ACVREP use the acronym COMS. A directory of certificants is available on the ACVREP website.

ACVREP mission statement

The mission of ACVREP is to offer professional certification for vision rehabilitation and education professionals in order to improve service delivery to persons with vision impairment. ACVREP is committed to quality certification programs that meet rigorous recognized standards. Programs are designed to offer certificants the means to demonstrate knowledge, skills, and professionalism.

Certification - Orientation & Mobility Specialists

ACVREP Certification requirements

For Initial Professional O&M certification (valid for 5 years):

- Graduate from an AER approved university program in O&M or related field (such as teacher of the visually impaired or rehabilitation teacher) and completion of O&M core curricula
- Successful completion of a National Examination in O&M
- Sign the O&M Code of Ethics

For Renewable Professional O&M Certification:

- Demonstrate sufficient professional experience and participation in continuing education and professional development activities
- Verification/documentation of above is sent to ACVREP

AER recognized university training programs require students to complete

- a minimum of 60 hours under blindfold or low vision simulators learning and practicing travel techniques and strategies they will teach to persons with visual impairments and multiple disabilities;
- a minimum of 340 hours of O&M practicum; and
- a practicum supervisor must be Certified O&M specialist with at least 2500 hours of O&M teaching experience.

[illegible]

For more information

ACVREP

ACVREP

~~P.O. Box 91047~~

Tucson, AZ 85752-1047

Phone (520) 887-6816

Fax (520) 887-6826

Website: www.acvrep.org

Certification - Orientation & Mobility Specialists

NBPCB

National Orientation and Mobility Certification N.O.M.C.

The National Blindness Professional Certification Board, Inc. (NBPCB) was created in June 2001. This Board was developed in large part through the support of the National Federation of the Blind (NFB).

At this time, the NBPCB offers one professional certification – the National Orientation and Mobility Certification. This certification emphasizes nonvisual instruction, structured-discovery learning, and performance-based examination in which persons must demonstrate their ability to perform the skills they will teach.

NBPCB believes that many persons who receive the training to teach O&M from agencies for the blind are as well qualified to teach travel to the blind as university trained professionals. (Braille Monitor, May 2002) NBPCB was developed as part of the U.S. Department of Education's Experimental and Innovative (E&I) Grant awarded to the Louisiana Rehabilitation Services, the state's public vocational rehabilitation agency.

Louisiana Tech University started an O&M master's program as part of this E & I grant.

From www.nfb.org/bm/bm02/bm0205/mb0205.htm

NBPCB certification requirements

National Orientation and Mobility Certification (NOMC) requirements demonstrate:

- Knowledge of the blindness field
- Positive attitudes about blindness
- Ability to perform travel tasks or techniques – both indoors and outdoors
- May or may not have an O&M degree from university

If the candidate for NOMC is sighted or partially blind, the performance part of the examination is conducted under blindfold. Three member certification teams conduct individual evaluations.

For more information

For more information, contact Dr. Ron Ferguson, Chairman of the NBPCP Board, at ferguson@lcb-ruston.com

Certification - Licensure of Professional Engineers

License	Engineers may have a license from the Professional Engineers State Licensing Board.
Professional engineers state licensure PE	Professional Engineers (PE)s have fulfilled the education and experience requirements and passed the rigorous exams that, under state licensure laws, permit them to offer engineering services directly to the public. PEs take legal responsibility for their engineering designs and are bound by the code of ethics to protect public health and safety. Every state, the District of Columbia, and U.S. territories have laws regulating the practice of engineering. The National Society of Professional Engineers (NSPE) is an engineering society that represents individual engineering professionals and licensed engineers (PEs) across all disciplines.
PE licensing requirements	Engineering licensure laws vary from state to state, but, in general, to become a PE an individual must: • Graduate from an engineering program accredited by the Accreditation Board for Engineering and Technology • Pass the Fundamentals of Engineering Exam • Gain 4 years experience working under a PE • Pass the Principles and Practice Engineering Exam www.nspe.org/aboutnspe.abl-what.asp Before obtaining licensure as a PE, engineers with less than 4 years experience (often new graduates or seniors in university programs) can obtain Engineers in Training (EIT) standing. Some states use different names. EIT certificate does not authorize the practice of engineering, but it does signify that the individual has • earned an engineering degree; and • passed the fundamentals exam.

Certification - Licensure of Professional Engineers

For more information PE license

NSPE
1420 King Street
Alexandria, VA 22314-2974
Phone (703) 684-2800
Fax: (703) 836-4875
Website: www.nspe.org

Certification – Professional Traffic Operation Engineers

Professional Traffic Operation Engineer certification

The Transportation Professional Certification Board, an autonomous non-profit organization, sponsors certification of Professional Traffic Operations Engineers (PTOEs). PTOEs must first hold state licensure as Professional Engineers.

The Institute for Transportation Engineers (ITE) provides significant support to the Certification Board. However, the Certification Board's policies for the award of certification are independent of ITE and one is not required to be an ITE member to obtain PTOE certification.

This voluntary certification was developed to help decision-makers discern which engineers hold skills appropriate for practice in the growing number of engineering specialties. PTOE certification is an indication of requisite knowledge, skill, and ability in the specialized application of traffic operations engineering.

www.ite.org/certification/certification_about.html

Certification requirements PTOE

Requirements for PTOE certification:

- Must be licensed as Professional Engineer (PE) in U.S. or Canada
- 4 years of professional practice in traffic operations engineering
- Pass a written examination in traffic operations

Keeping the certification valid requires the holder to regularly upgrade knowledge and skills through continuing education. The Certification Board has a directory of PTOEs.

For more information

Transportation Professional Certification Board, Inc.

1099 14th Street, NW

Suite 300 West

Washington, D.C. 20005-3438

Phone: (202) 289-0222

Fax: (202) 289-7722

Email: certificant@ite.org

Certification - Traffic Signal Technicians

Signal technicians

Signal technicians work under the direction and guidance of traffic engineers. Their responsibilities may include:

- Install wiring and hardware for traffic controls, and pedestrian and traffic signals
- Program traffic controllers, as per engineer's directions
- Repair damaged or malfunctioning controllers
- Install APS hardware
- May conduct field studies to determine traffic volume, speed, effectiveness of signals, adequacy of lighting, and other factors influencing traffic conditions, under direction of traffic engineer.

Many signal technicians are trained as electricians or through an apprenticeship with an experienced signal technician.

Certification

Traffic signal technicians may be certified by International Municipal Signal Association (IMSA). IMSA began certifying individuals involved with various public safety activities in 1983. Persons seeking certification must obtain a certification manual for the appropriate program and level and pass a proctored examination.

There are three levels of certification for signal technicians Level II requires an exam, with supplemental questions in the area of signal technician or signal electrician. Level III requires five years of experience in the traffic signal field.

For more information

IMSA

P.O. Box 539

165 East Union Street

Newark, NY 14513-0539

Phone: (800) 723-4672

Fax: (315) 331-8205

Email: info@IMSAsafety.org

Module 2A

Intersection Control and Actuation

(for dog guide instructors, O&M specialists, travel instructors, and individuals who are blind or visually impaired)

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Objectives –Module 2A – Intersection Control and Actuation

Lecture Discussion (45 minutes)

The participant will gain an understanding of:

- Modern traffic control and intersection design and their effect on the travel of pedestrians who are blind or visually impaired (5 minutes)
- Intersection signalization and signal timing plans (25 minutes)
- Warrants for signalization in the Manual on Uniform Traffic Control Devices (10 minutes)
- How to work effectively with Traffic Engineering Departments and Staff (5 minutes)

Outdoor Experiential exercise

(45 minutes)

The participant will gain a better understanding of traffic controls and intersection designs by:

- Analyzing traffic at two pre-selected intersections near the conference site
- Reviewing the intersection signalization and timing plans

Introduction

Skills and strategies used by pedestrians who are blind or visually impaired to cross streets at signalized intersections were developed for intersections that had pre-timed signals, which meant the cycle changed on a regular basis, traffic could not turn on a red signal.

Over the years, we have seen the geometry of intersections become more complex with the addition of multiple roadways, medians, islands, right turn lanes with right turns permitted on red and the construction of roundabouts. Signalization has become more complex, with the introduction of vehicular and pedestrian actuation and multiple phasing. More complex signalization and geometry make some previously accessible intersections now inaccessible for pedestrians with disabilities.

Thus, it is important for O&M specialists to understand these changes at signalized intersections so they can adapt their instructional techniques and advocate for their consumers' needs.

Changes in Traffic Control and Intersection Design

Why has it changed?

Quick review and discussion

(5 minutes)

Due to demographics, population increases, mass transit, expanding roadway networks, more vehicles and fast-paced lifestyle:

- Employment and residential populations have moved out of the inner city creating suburban and active rural development
- The historic commuter trip to the central city has diminished, creating the need for additional suburban and urban arterials to accommodate inter-area traffic
- Steady traffic volume increases on high-speed arterials increased need for expanded geometric design and complex traffic signal control
- High-volume intersections require specialized/complex intersection traffic signal control and phasing; computer-based equipment is used to "optimize" the control of signalized intersections
- Officials and citizens placed additional responsibility on transportation professionals to accommodate increased traffic volumes on arterials while accommodating other travel modes

Changes to Streets

Change:

- Arterial and collector roadways can be wider (i.e., more lanes of traffic) to accommodate increased vehicle volume
- Corner radii are wider (i.e., larger radius) to accommodate truck traffic and more efficient turns
- Medians and islands are used to separate various traffic movements

Effect on pedestrians who are visually impaired or blind:

- Increased time is necessary for pedestrians to cross
- Street crossing may require two pedestrian walk intervals (the first to cross to the center median, the second to complete the crossing)
- Vehicles (cars, transit and trucks) turn faster
- Wider streets, combined with gaps in parallel traffic increase potential for veers out of crosswalk area
- Rounded corners can make initial alignment more difficult, which increases the chance for veering out of the crosswalk area

Changes in Traffic Control and Intersection Design

Addition of Curb ramps

Change:

- Curb ramps were added at many corners to provide access for pedestrians with mobility impairments

Effect on pedestrians who are visually impaired or blind:

- Some ramps are undetectable due to very gradual slopes, making it difficult to locate the street edge
- One large ramp at the center of the curb radius is often used instead of separate, smaller ramps aligned with each crosswalk. This makes it harder for persons with visual impairments to align for crossing, and for persons with disabilities who use wheelchairs to avoid traffic in the parallel street
- No curb at the opposite side of the crosswalk makes it difficult to locate the edge of the roadway/beginning of sidewalk
- It is more difficult to align pushbutton and APS devices with ramp locations

---

Complex intersection design

Change:

- More than two roadways may cross at a specific intersection leading to four or more approach roadways
- Traffic movements are separated with channelization by using medians, islands, or pavement markings to increase safety and improve operational control
- Right turn lanes and through lanes (with "T" intersections) can be separated from the other intersection traffic movements with channelization and allowed to run continuously (i.e., "free flow"), outside of the traffic signal control
- Modern roundabouts (rotaries) are used in place of traditional signalized intersections; under the appropriate conditions, roundabouts can increase the vehicle-carrying capacity of an intersection and reduce vehicular crash potential

Effect on pedestrians who are visually impaired or blind:

- Multiple intersection approaches may require angled crossing and may increase the tendency to veer outside

Changes in Traffic Control and Intersection Design

of the crosswalk area

- The sound of vehicles that are continually moving in channelized lanes interferes with ability to hear parallel vehicle surge, and traffic moving on the major street. This prevents pedestrians from hearing gaps in traffic to cross the unsignalized turn lane
- Crosswalks can be hard to locate non-visually
- Medians and islands can't be detected from the curb through auditory or physical cues
- Presence of cut-throughs at islands and medians sometimes results in the inability of pedestrians who are blind or visually impaired to recognize islands or medians when they encounter them

Effect on pedestrians who have mobility impairments:

- Lack of ramps or cut-through at islands can prevent access

Changes in intersection signalization and control

Change:

- Higher volume roadways and larger left- and right-turn volumes has led to changes in signal control (changed from 2-phase operation to multi-phase operation) and longer cycle lengths

Traffic actuation:

- Traffic actuation has been added to change traffic signal timing from pre-timed patterns to variable-time patterns.
- In theory, traffic actuated control provides only enough green time on each approach to satisfy the demand, allowing for a more efficient servicing of each approach.
- If no vehicles are detected on a given intersection approach, no green time will be provided and the associated phase will be skipped.
- The result of traffic actuated signalization is that signal timing (each phase and overall cycle length) can vary with traffic demand

Changes in Traffic Control and Intersection Design

- In traffic actuated control intersections, the pedestrian phases are actuated as well. Therefore, a pedestrian phase may be skipped if the pedestrian push button is not pushed.

Effect on pedestrians who are visually impaired or blind:

- They may not be aware of actuation and timing variability which may result in insufficient time to execute the crossing
- They may not be aware that they must push buttons to get a pedestrian walk phase which may result in a crossing being initiated during the wrong interval
- They cannot anticipate when the pedestrian phase will begin because the order of vehicular movement may change from cycle to cycle
- They may not realize that at some intersections with medians, timing may not be sufficient for crossing the entire street without stopping on the median and pushing another button

Right turn on red

Change:

- Right turn on red, (and left turn on red at two one-way streets) is now permitted at most intersections

Effect on pedestrians who are visually impaired or blind:

- Vehicles can turn right during all phases making it harder for them to tell when the WALK interval begins
- They can't start crossing as soon as they hear a vehicle move on the parallel street; they must wait to hear a vehicle going straight to be sure the light changed

Other Challenges

Aggressive drivers

Change:

- Aggressive drivers find it difficult to patiently wait for pedestrians to cross; placing additional pressure on pedestrians to cross rapidly
- Aggressive drivers tend to focus on vehicular movement

Effect on pedestrians who are visually impaired and blind:

- When pedestrians hesitate, even slightly, drivers may interpret this as an indication that the person will not be crossing at this time
- Pedestrians have to wait several light cycles to cross at intersections with
  - high volumes of right turning cars;
  - channelized right turn lanes; and
  - uncontrolled (mid-block) crosswalks.

Intersection Signalization and Timing Plans

Intersection signalization

Intersections are designed to provide optimal traffic flow. Timing plans may be of three general types:

- Fixed time (or pre-timed)
- Semi-actuated
- Actuated

Timing plans at a given intersection can be switched from actuated to fixed timed to flashing mode depending upon

- time of day (peak periods vs. non-peak periods);
- day of week; and
- Malfunctions due to power outages.

O&M specialists role:

- It's important for O&M specialists to understand the vehicular signals as well as the pedestrian signals and the relationship of the timing.
- They must, in turn, teach these concepts to their students.

There is some variability in timing plans in different municipalities and in different locations, depending on the roadway needs.

Fixed time or pre-timed intersection

Operate in predetermined and predictable fashion:

- Regularly repeated sequence of 30 seconds or more for each traffic approach (leg), regardless of traffic flow
- Common and still found in many locations

Intersection Signalization and Timing Plans

Actuated intersection

Actuated intersections:

- Have signal timing (phases and cycles) that are not of fixed length-change in response to variations in the volume and speed of traffic
- Have detectors to monitor traffic and send signals to the traffic signal controller to change; detectors are most often inductive loops (electric) or they may be magnetic, microwave, video, and other detection technologies
- Pushbuttons are required for pedestrian detection; other technologies (microwave, infrared, piezoelectric) may be used
- Actuated intersections are most often used where traffic volumes fluctuate irregularly, and it is desirable to minimize interruptions to traffic flow on the major street

Types of actuated intersections include:

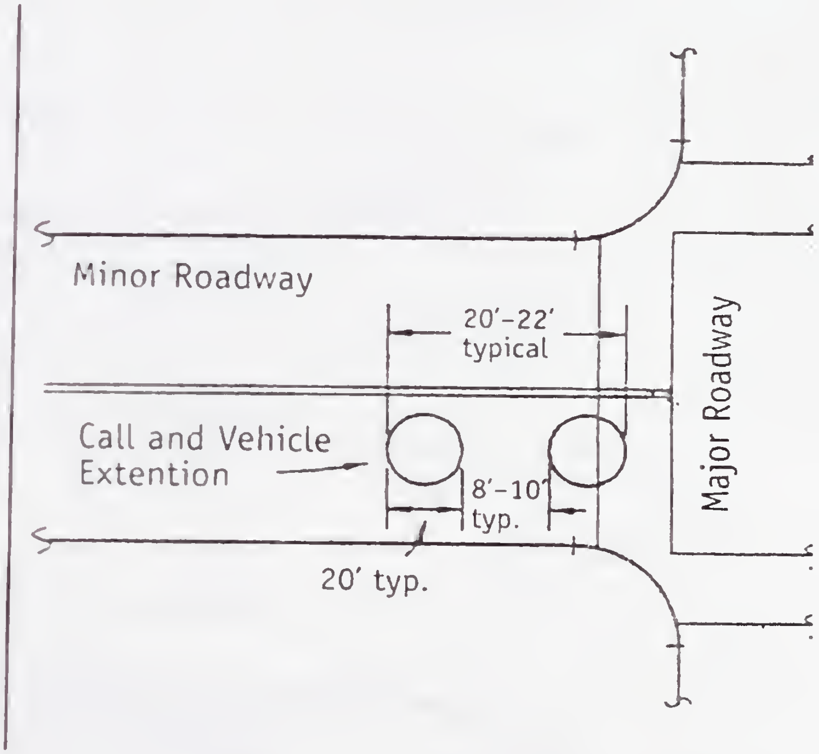
- Semi-actuated - only the low volume roadways have detectors; main roadway stays in green until a side street detection is received
- Actuated turn lanes - used to activate turn phases when turn volume is large
- Fully actuated intersections – all movements/ phases are actuated

Intersection Signalization and Timing Plans

Semi-actuated intersection

Semi-actuated intersections are common along major streets:

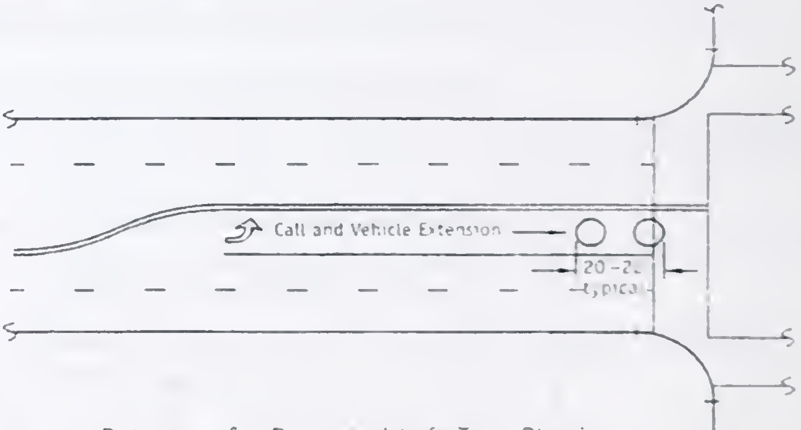
- Assign a green interval to the major street or arterial
- Stays green unless traffic (including pedestrian traffic) on the minor street is detected causing the traffic signal to change (i.e., service the side street demand)
- Vehicle detectors only on the minor street
- Pedestrian detection required to activate pedestrian phase for crossing arterial
- Minor street may have a "rest in walk" for the visual pedestrian signal and have no pushbutton



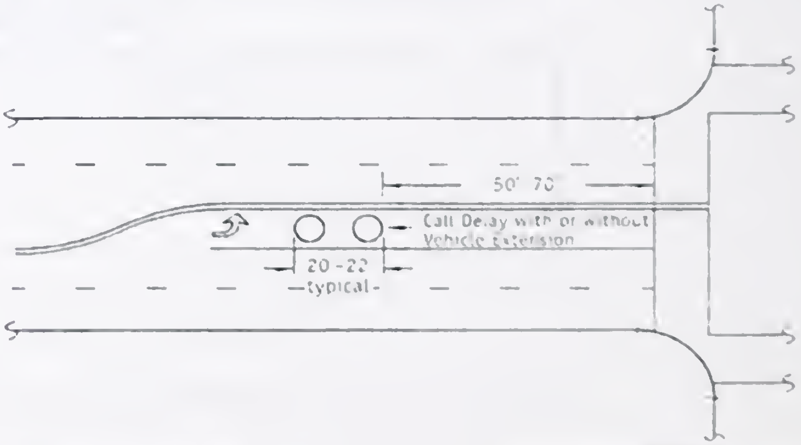
Intersection Signalization and Timing Plans

Actuated turn lanes

- Same type of actuation as through movements, applied to turn movements
- Used to determine the demand for a turn phase
- If vehicles are waiting in a turn lane at the start of a turn phase, the phase will be implemented and a protected turn movement provided. If no vehicles are detected in the turn lane, the turn phase can be skipped.
- Since left-turn phases require through movements to be stopped, adding delay and inefficiency, left-turn phases are usually installed only when the demand is present



Detectors for Protected Left-Turn Phasing

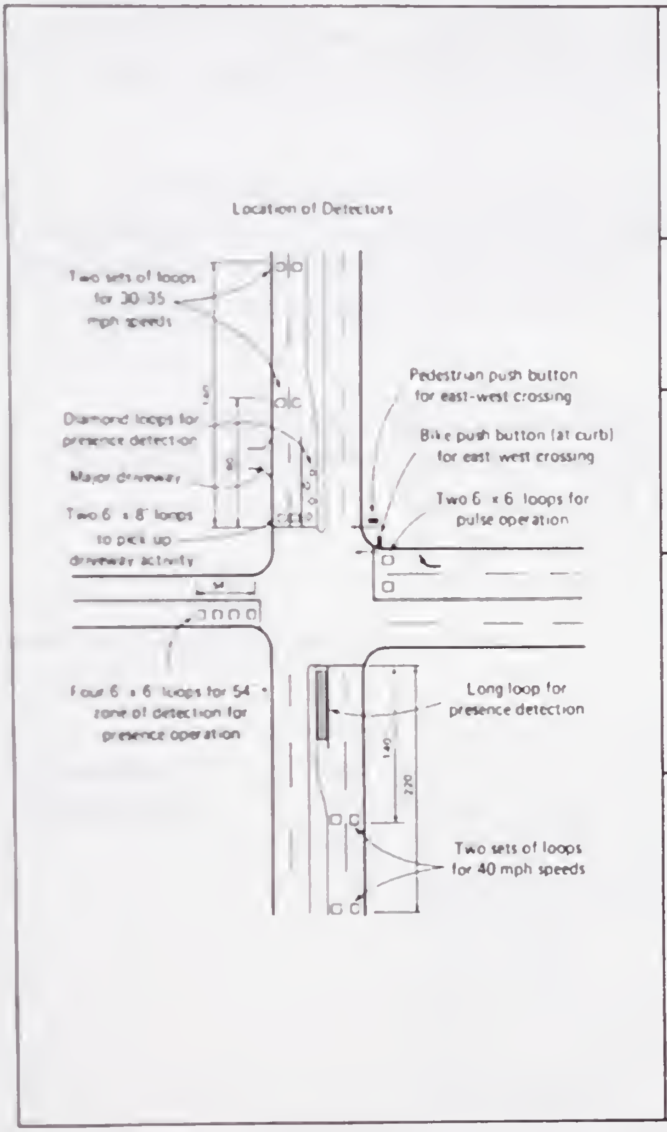


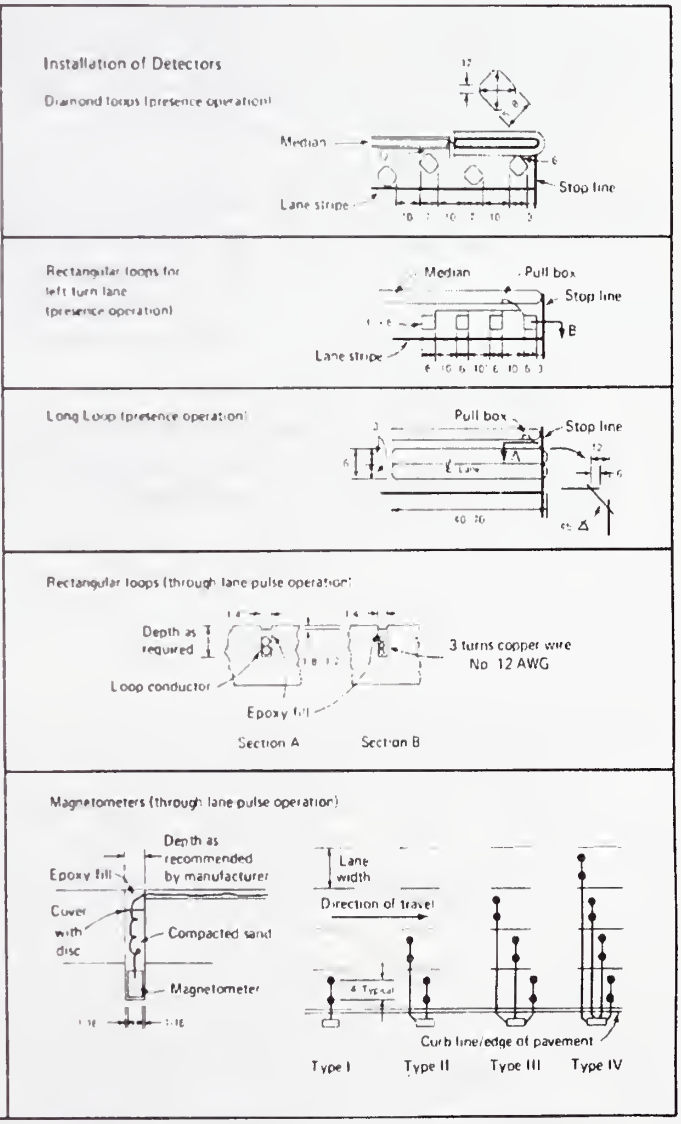
Intersection Signalization and Timing Plans

Fully actuated intersections

Fully actuated intersections are common at the intersection of two arterials:

- Detectors for vehicles and pedestrians on all approach lanes and pedestrian crossings
- Used when traffic volumes on each approach vary by time of day
- Changing traffic volume can result in difference in timing for every cycle


Location of Detectors
Two sets of loops for 30-35 mph speeds
Diamond loops for presence detection
Major driveway
Two 6' x 8' loops to pick up driveway activity
Pedestrian push button for east-west crossing
Bike push button (at curb) for east west crossing
Two 6' x 6' loops for pulse operation
Four 6' x 6' loops for 54' zone of detection for presence operation
Long loop for presence detection
140
220
Two sets of loops for 40 mph speeds


Installation of Detectors
Diamond loops (presence operation)
Median
Stop line
Lane stripe
Rectangular loops for left turn lane (presence operation)
Median
Pull box
Stop line
B
Lane stripe
Long Loop (presence operation)
Pull box
Stop line
A
40-70
Rectangular loops (through lane pulse operation)
Depth as required
Loop conductor
Epoxy fill
3 turns copper wire No. 12 AWG
Section A
Section B
Magnetometers (through lane pulse operation)
Epoxy fill
Depth as recommended by manufacturer
Cover with disc
Compacted sand
Magnetometer
Lane width
Direction of travel
4' Typical
Curb line/edge of pavement
Type I
Type II
Type III
Type IV

Intersection Signalization and Timing Plans

Split or non-concurrent phasing

- In most cases, the northbound and southbound through movements run simultaneously, as well as the eastbound and west bound through movements. Split phasing provides separate green time to opposing approaches.
- At offset intersections and other locations where this may provide a safety problem, split phasing is used.

Example of northbound/southbound movements running under split phasing:

1. Northbound traffic, including traffic turning east and west, moves on one signal phase, (southbound traffic and all traffic on the E/W street have a red signal at that point)

2. Northbound traffic receives a red signal while all southbound traffic, including turning traffic, is allowed to go. (Pedestrian phases for crossing north or southbound on the east and west side of the N/S street will be at different times)

3. Eastbound and westbound traffic move together (concurrently), northbound and southbound traffic is stopped

Intersection Signalization and Timing Plans

Turning phases

Concurrent:

- Two directional approaches (eastbound and westbound) proceed together as the opposing directional approaches (northbound and southbound) are stopped. Often referred to as dual left-turn phasing. Concurrent left turns are by definition 'protected.'

Permissive:

- A "permissive" turn is made across an opposing through vehicle flow. The driver is "permitted" to cross the opposing through flow, but must select an appropriate gap in the opposing traffic stream through which to turn. The driver must also yield to pedestrians lawfully within the intersection. This is the most common type of left-turn phasing at signalized intersections, used when left-turn volumes are not excessive and where adequate gaps of sufficient size exist in the opposing traffic to accommodate turns safely.

Protected:

- A "protected" turn is made without opposing through vehicular traffic or pedestrian crossing. The signal phasing "protects" vehicles by prohibiting the opposing movements. Protected turns require a separate signal phase, leading to multiphase signalization, (i.e., more than two phases at the intersection).

Flashing operations

Signals may only operate during peak periods of the day and may switch to flashing operation at non-peak hours, late at night, or in response to a signal malfunction:

- Signals no longer operating under stop-and-go sequencing
- Usually flashing red on side streets and yellow on main street
- Pedestrian signal heads (walk/don't walk signs) are dark; APS is silent

Intersection Signalization and Timing Plans

Coordinated systems

Coordinated systems provide automated control of signal timing to two or more signalized intersections.

Instead of looking at an intersection in isolation, coordinated systems look at an entire arterial or network of intersections and make signal timing adjustments that benefit (optimize) the operation of the entire system.

System changes are a result of traffic volume and travel times. Most often, a central controller (computer) provides the primary control and communicates with individual controllers at each intersection.

Coordinated control has a number of advantages:

- Signals can be controlled from a central traffic management center
- The detection elements of the system can be used to predict future flows within the network and adjust the signal timing proactively instead of reactively

Vehicular Signals and Timing

Meaning of signals

The use of particular traffic signal colors and symbols, and their meaning, is described in Part 4 of the MUTCD. Signs and pavement marking used at signalized intersections are covered in Parts 2 and 3 of the MUTCD, respectively.

Steady green signal

Circular green:

- Traffic, except pedestrians, may proceed straight through or turn right or left except as such prohibition signs or markings modify movement. All traffic, including vehicles turning right or left, shall yield the right-of-way to other vehicles and pedestrians lawfully within the intersection.

Green Arrow:

- Traffic, except pedestrians, may cautiously enter the intersection only to make the movement indicated by the green arrow. Vehicular traffic shall yield the right-of-way to pedestrians lawfully within an adjacent crosswalk and to other traffic lawfully using the intersection.

Pedestrian movement:

- Pedestrians may cross unless green arrow indicates conflicting traffic will cross into their path

Steady yellow signal

Steady yellow signal:

- Warning, green interval is ending and red signal will begin

Pedestrian movement:

- Pedestrians do not have enough time to cross, and should not initiate a crossing

Vehicular Signals and Timing

Steady red signal	Steady red signal: • Stop at the stop line, before the crosswalk lines, or before the intersecting street Right turn on red: • Unless a sign prohibits right turn on red, vehicles must come to a complete stop then proceed with the turn • Vehicles turning must yield right-of-way to pedestrians and traffic already in the intersection Left turn on red: • A turn from a one-way street onto another one-way street (same procedure as stated above) Red arrow: • Vehicles will stop at a stop line, before the crosswalk lines, or before the intersection and not go until they receive a green arrow Pedestrian movements: • Pedestrians should not enter the roadway
Flashing yellow	Flashing yellow: • Proceed with caution, treated like Yield sign
Flashing red	Flashing red: • Stop, then go, treated like Stop sign
Flashing red arrow & flashing yellow arrow	Flashing red and/or yellow arrows: • Same meaning as flashing circular signal indication, except they apply only to vehicular traffic intending to make the movement indicated by the arrow • Flashing circular yellow and yellow arrow indications may be used during stop-and-go traffic signal operations for permissive left-turn indications • Flashing circular red and red arrow indications may be used during stop-and-go traffic signal operations for permissive left-turn indications

Vehicular Signals and Timing

Vehicular timing

At an actuated location:

- The lengths of the green, yellow and red signals, as well as the pedestrian signals (see section on pedestrian signals and timing) are determined by the traffic controller
- Each leg of the intersection may have different phasing and timing

An example of timing at a semi-actuated intersection:

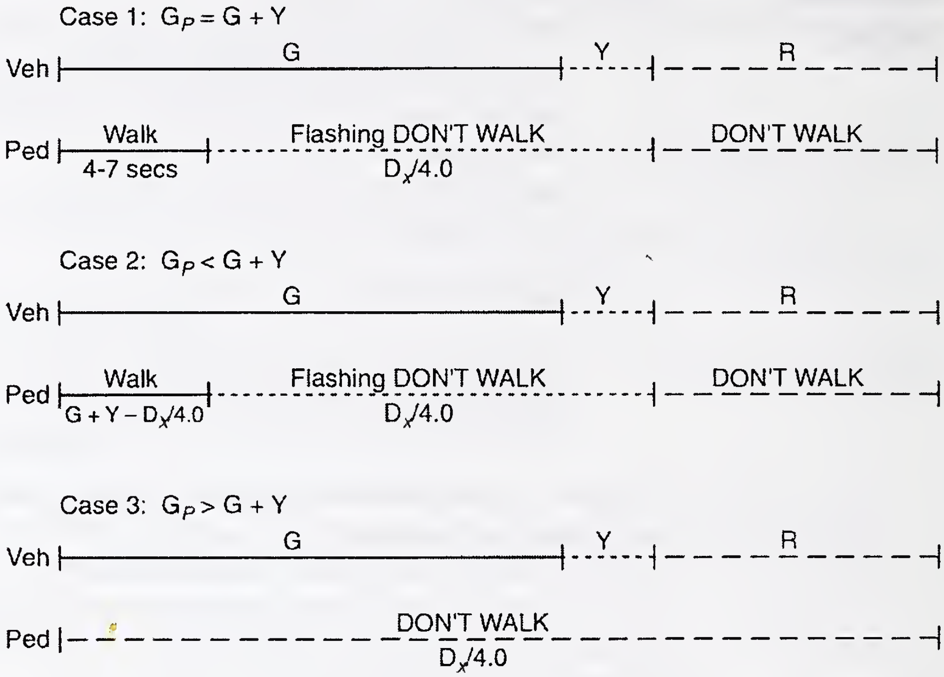
- Major street will have green unless a vehicle or pedestrian on the minor street is detected
- When the minor street gets the green

The first vehicle will be provided with a fixed amount of time (minimum green time) to proceed. The minimum green time can be extended up to a maximum green time depending on the number of additional minor street vehicles that were successfully detected. Several strategies exist on methods to extend the minimum green time:

- A yellow change interval of 3 to 6 seconds (typically) will be presented
- There may be a red clearance interval with a duration of 1 to 2 seconds, typically
- Green for the major street again until another call is received

Vehicular Signals and Timing

Timing graphic



Must provide pedestrian push-button. When actuated, next green phase conforms to Case 1, above.

Pedestrian Signals and Timing

Visual pedestrian signals

At intersections where engineers think there is the possibility of confusion for pedestrians looking at the traffic signal (amongst other reasons), pedestrian signal heads (Pedheads) are installed to signal pedestrians when to cross.

Pedheads:

- Walk interval - White WALK or symbol of a person walking to signal persons to begin crossing
- Change interval - Orange flashing DON'T WALK or flashing hand when pedestrians are not supposed to start crossing, since there is not enough time left in the phase for most pedestrians to get all the way across the street
- Don't walk interval - Steady orange DON'T WALK or hand when pedestrians are not supposed to be in crosswalk

One Section

Pedestrian countdown signals:

- Provide the countdown in seconds for the remaining time allotted during the change interval. (countdowns are a fairly new type of signal which supplement the WALK/DON'T WALK signals, rather than replace them)
- Unclear if additional countdown information provides pedestrians with an ability to execute quicker crossings
- Countdown information encourages pedestrians to begin crossing during the change interval

Pedestrian Signals and Timing

Pedestrian timing

Typical timing:

- Walk interval is typically very short (4 to 7 seconds)
- Change interval is long enough for a pedestrian to cross the street, (time depends on width of street), usually calculated with a walking speed of 4 feet per second (crossing distance/4 to the middle of the last travel lane. Parking lanes may be excluded from the calculation)

Pedestrian phase actuation

If there is a pedestrian pushbutton:

- Activating pushbutton calls a pedestrian phase which allows enough time for the pedestrian walking the average speed to cross
- Without pushing the button, there may not be enough time programmed into the vehicular phase for a pedestrian to cross the street
- If the button is pressed, the pedestrian phase will begin at a certain point during the following cycle. There may be some delay before it begins, depending on the programming of the phases for that intersection

Passive pedestrian detection

Passive pedestrian detection:

- Pedestrians may be detected passively (without pushing a button) as they approach the crosswalk area through the use of microwave, infrared or piezoelectric technologies (see module 4 for additional information)
- Future developments may impact whether or not an APS with a locator tone is necessary at an intersection with passive detection
- Pedestrians may not realize they have been detected

Pedestrian Signals and Timing

Leading pedestrian intervals

Leading pedestrian intervals are intended to give an advantage to pedestrians:

- Walk interval begins 2 to 4 seconds before vehicular green
- Pedestrians get a head start so they are in the intersection before vehicles start up
- Pedestrians who are blind or visually impaired who rely on the surge of traffic to recognize when the signal is green are at a disadvantage. Because they cannot see the WALK signal, they start crossing with the surge of parallel traffic. This gives them less time to cross. Also, when they don't initiate the crossing at the onset of the WALK interval) drivers may interpret this as the pedestrian not intending to cross during this cycle.
- Pedestrians who are blind or visually impaired don't know about the leading pedestrian interval at unfamiliar intersections unless there is an APS installed

Exclusive pedestrian phasing

Also known as scramble crossing:

- All vehicles have a red light during the WALK interval
- All crosswalks have the WALK signal at the same time
- At some intersections, crossings may be made diagonally (for pedestrian efficiency). Diagonal crossings are difficult to detect for pedestrians who are visually impaired or blind.
- Done to increase pedestrian safety
- In some locations, right turn on red is allowed during the pedestrian phase
- May prove very beneficial to pedestrians with mobility impairments and cognitive disabilities as it allows them to cross when no or few vehicles are moving through the intersection
- Disadvantage for pedestrians who are blind or visually impaired who must rely on traffic sounds to determine the signal phases rather than an APS because as the vehicular sounds are not available to initiate the crossing or to provide guidance across the intersection. People report they cannot discern the WALK interval.

MUTCD Warrants and Signalization

What is a warrant?

Prior to the installation of a traffic control signal, certain warrants or conditions must be met to ensure that installation will result in efficient and safe traffic flow.

MUTCD specifies eight ‘traffic control signal needs studies’, known as warrants, one of which must be met at an intersection to justify installation of a traffic signal at the intersection.

However, “The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal.” (MUTCD 2000, 4C.01) The final decision is made based upon the traffic engineer’s judgment.

Process to determine if signal is warranted

Traffic engineer analyzes vehicular movement, pedestrian movement, intersection history and the physical environment in order to determine whether or not the intersection warrants a traffic control signal..

Engineers examining the intersection may review the following:

- Number of vehicles entering the intersection from all directions during a 24-hour period
- Vehicular volumes during peak hours, classified by vehicle type for traffic movement in all directions
- Pedestrian volume on each crosswalk in all directions, including children, the elderly, and/or persons with physical or visual disabilities, during each hour of the day
- Requests from or participants in nearby facilities and activity centers that serve the young, elderly, and/or persons with physical or visual disabilities
- Posted speed limit
- Physical layout
- Crash experience

Different warrants require detailed analysis of different aspects of the above information.

Information on two of the signal warrants is included below to illustrate some of the considerations.

MUTCD Warrants and Signalization

Warrant 1- Eight- Hour Vehicular Volume

Description of Warrant 1 conditions

- "The Minimum Vehicular Volume, Condition A, is intended for application where a large volume of intersecting traffic is the principal reason to consider installing a traffic control signal." (MUTCD 2000 4C.02)
- "The Interruption of continuous Traffic, Condition B, is intended for application where the traffic volume on a major street is so heavy that traffic on a minor intersecting street suffers excessive delay or conflict in entering or crossing the major street." (MUTCD 2000 4C.02)

Engineers evaluate the vehicles per hour and a certain volume must be met in order to justify installation. A complex table is used which includes number of lanes of moving traffic for each approach, vehicles per hour on major street, and vehicles per hour on higher volume minor street approaches.

FOR USE during discussion of warrant example during workshop

FROM Section 4C.02, MUTCD 2000

Warrant 1, Eight-Hour Vehicular Volume

Standard:
The need for a traffic control signal shall be considered if an engineering study finds that one of the following conditions exist for each of any 8 hours of an average day:

A. **The vehicles per hour given in both of the 100 percent columns of Condition A in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection; or**

B. **The vehicles per hour given in both of the 100 percent columns of Condition B in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.**

In applying each condition the major-street and minor-street volumes shall be for the same 8 hours. On the minor street, the higher volume shall not be required to be on the same approach during each of these 8 hours.

Option: If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 70 km/h (40 mph), or if the intersection lies within the built-up area of an isolated community having a population of less than

10,000, the traffic volumes in the 70 percent columns in Table 4C-1 may be used in place of the 100 percent columns.

Condition A —Minimum Vehicular Volume

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)			Vehicles per hour on higher-volume minor-street approaches (one direction only)		
Major Street	**Minor Street**	**100%[a]**	**80%[b]**	**70%[c]**	**100%[a]**	**80%[b]**	**70%[c]**
1	1	500	400	350	150	120	105
2 or more	1	600	480	420	150	120	105
2 or more	2 or more	600	480	420	200	160	140
1	2 or more	500	400	350	200	160	140

Condition B—Interruption of Continuous Traffic

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)			Vehicles per hour on higher-volume minor-street approaches (one direction only)		
Major Street	**Minor Street**	**100%[a]**	**80%[b]**	**70%[c]**	**100%[a]**	**80%[b]**	**70%[c]**
1	1	750	600	525	75	60	53
2 or more	1	900	720	630	75	60	53
2 or more	2 or more	900	720	630	100	80	70
1	2 or more	750	600	525	100	80	70

[a] Basic minimum hourly volume.

[b] Used for combination of Conditions A and B after adequate trial of other remedial measures.

[c] May be used when the major-street speed exceeds 70 km/h (40 mph) or in an isolated community with a population of less than

MUTCD Warrants and Signalization

Warrant 4 – Pedestrian Volume

Description of Warrant 4 conditions:

- "The Pedestrian Volume signal warrant is intended for application where the traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street." (MUTCD 2000 4C.05)

As currently written, the warrant requires fairly large volume of pedestrians crossing at a location.

"The need for a traffic control signal at an intersection or mid-block crossing shall be considered if an engineering study finds that both of the following criteria are met:

- The pedestrian volume crossing the major street at an intersection or mid-block location during an average day is 100 or more for each of any 4 hours or 190 or more during any 1 hour; and
- There are fewer than 60 gaps per hour in the traffic stream of adequate length to allow pedestrians to cross during the same period when the pedestrian volume criterion is satisfied. Where there is a divided street having a median of sufficient width for pedestrians to wait, the requirement applies separately to each direction of vehicular traffic." (MUTCD 2000 4C.05)

In addition:

- "The Pedestrian Volume signal warrant shall not be applied at locations where the distance to the nearest traffic control signal along the major street is less than 90 m (300 ft), unless the proposed traffic control signal will not restrict the progressive movement of traffic." (MUTCD 2000 4C.05)

However:

- "The criterion for the pedestrian volume crossing the major roadway may be reduced as much as 50 percent if the average crossing speed of pedestrians is less than 1.2 m/sec (4 ft/sec)." (MUTCD 2000 4C.05)

MUTCD Warrants and Signalization

For more information

MUTCD Millennium Edition can be downloaded from website:

http://mutcd.fhwa.dot.gov/kno-millenium_12.28.01.htm

Chapter 4C. Traffic control signal needs studies.

Collaboration

Contacting local transportation professionals

Transportation professionals may consist of traffic engineers, public works personnel, signal technicians and/or traffic planners. In some cases, local consulting engineering firms are contracted to provide operation and maintenance control of signalized intersections. The ownership of the signal, whether it is at the township, county, city or state level, designates which transportation professional would be in charge of the intersection.

Make contact with the transportation professional by contacting your local government office. Work in a collaborative manner and develop a productive working relationship:

- Talk with the transportation professional and familiarize yourself with the procedures he or she must go thru in order to accommodate your request
- Understand there are at times additional parties and/or factors involved when addressing your request (funding, politics, etc)
- Ask transportation professionals about signal phasing and timing plans at particular intersections and how pedestrians are accommodated

Collaboration

Understand municipality structure

Structure varies from municipality to municipality:

- Engineering may be part of public works or may be separate department
- Intersection signals may be part of a state or county traffic management network, even if within a town or city, or may be managed by a consulting firm
- New construction of intersection may be contracted out to a traffic engineering or electrical contractor
- Signals may be maintained by a different department than the one that installed them
- Learn if there is a local jurisdiction wide ADA coordinator and/or a Department of Transportation/Public Works Department ADA coordinator
  - Coordinator may ensure that the local jurisdiction's streets, sidewalks and facilities are accessible to pedestrians with disabilities
  - Coordinator may have more influence in getting traffic engineers to install accessible signals than someone outside of the local jurisdiction

To learn about the structure check city web site or check phone directory for offices and structure information.

Contact person in traffic engineering department

Call the department that manages traffic signals and ask who to talk to about a specific intersection.

- Call and explain to the transportation professional what you do and why you want to know about the intersection (people responsible for the traffic signals may not have thought about persons who are blind or have other disabilities traveling and may not know that professionals exist in this field).
- Ask that person in charge for more information about who does what and how to ask for information.
- Find out the procedure for requesting changes or modifications to an intersection.

Collaboration

Attend meetings

Meetings:

- Consider attending local ITE meetings or other engineering professional meetings
- Consider attending local Disability Advisory Committee meetings. The Disability Advisory Committee reports directly to elected officials (Mayor, City Council, County Board of Supervisors) of the local jurisdiction
- If the Disability Advisory Committee has a Physical Access Subcommittee the O&M specialist may want to become a permanent member in order to have an opportunity to advocate for and influence future installations of accessible signals

Public hearings

Be aware of Transportation Improvement plan public hearings:

- Opportunities to meet Department of Transportation staff and/or traffic engineers
- Present brief comments on needs of pedestrians who are visually impaired or blind or have other disabilities

Educate yourself

Keep informed:

- Familiarize yourself with APS installations in your area or nearby areas
- Learn the language used by traffic engineers
- Familiarize yourself with state regulations and practices such as MUTCD, ADA Title II and Draft Guidelines for Accessible Public Rights-of-Way
- Learn the desires of others in your community
- Remain informed on current APS technology
- Follow up on any requests and don't assume someone else is doing everything right
- Learn where to report problems or malfunctions

Collaboration

Educate your students

Responsibilities to students:

- Teach students about changes in signalization and geometries
- Explain necessity of using pushbuttons at actuated intersections
- Remind students that timing plans can vary so that the signal timing they identify when crossing the intersection at a specific time of day or day of week may be different the next time they use the same intersection
- Assist students when they request an APS

Advocate for APS

Advocate for APS at intersections when:

- Pedestrians who are visually impaired or blind can’t discern WALK interval due to such factors as:
    - Intersection noise
    - Intermittent traffic
    - Complex intersection geometry
    - Large number of turning vehicles
    - Split phase timing
- Pedestrian pushbutton controls pedestrian crossing phase
- Signalization includes:
    - Leading pedestrian interval
    - Exclusive pedestrian phasing
- Many electric or hybrid vehicles are present

Experiential Exercise

Purpose

The purpose of this exercise is to give the participants exposure to the many variables involved when identifying timing patterns at a semi or fully actuated intersection. The participants will measure time available for crossing during the pedestrian phase at actuated intersections, which have pushbutton, actuated pedestrian phasing verses time available for crossing the same crosswalk with vehicular green. The participants will discuss their findings and offer solutions to make the intersection more accessible.

Small groups

The participants will be divided into two groups and assigned a pre-selected intersection.

Intersection tasks

(25 minutes)

At the assigned intersection:

- Group will identify phases and intervals available to cross for each cycle
- Determine length of vehicular green for a crosswalk during several cycles without calling a pedestrian phase
- Determine length of the pedestrian phase during several cycles when the pushbutton is pushed for that crosswalk,
- Note length of the pedestrian change interval
- Note sequence of phases, if sequence changes and how
- Note information which can be gathered by listening and instances in which that information might not be accurate or adequate for determining onset of the WALK interval

Materials

Materials needed for outdoor exercise:

- Stop watch
- Measuring wheel (to measure distance across street)
- Intersection diagram
- Clipboard & pencils
- Timing plans

Group review

10 minutes

Group will review the timing plan for the intersection

- to develop an understanding of how the sequence and phasing might change over the course of the day; and
- to develop their understanding of information available to the engineer.

Experiential Exercise

Discussion

10 minutes

Discuss impact of intersection timing and signalization on decisions about crossing for pedestrians with disabilities.

- Review issues addressed earlier in the module regarding the problems persons with disabilities are faced with at those intersections.

Possible solutions and putting those issues into collaborative terms for productive communication with traffic engineers.

Module 2B

Street Crossings at Signalized Intersections for Pedestrians with Disabilities

(for traffic engineers)

Some pages or sections in this module are from *Draft, Accessible Pedestrian Signals: Synthesis and Guide to Best Practice* (January 4, 2002) by Barlow, Bentzen and Tabor, prepared as part of NCHRP 3-62. Used with permission.

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Objectives – Module 2B – Street Crossings at Signalized Intersections for Pedestrians with Disabilities

Lecture & discussion

(45 minutes)

Through discussion, slide presentations, and videos the participant will gain an understanding of

Types of vision loss and their mobility implications

The fields of Orientation and Mobility and Travel Instruction

Strategies and techniques to cross streets at signalized intersections used by pedestrians who are:

- Visually impaired or blind
- Deaf-blind
- Mobility impaired
- Cognitively impaired

Barriers or challenges that limit safety and independence of persons with disabilities crossing at signalized intersections

Suggestions to enhance safety and to remove barriers at signalized intersections

Outdoor Experiential Exercise

(45 minutes)

At a signalized intersection, participants will be asked to wear either a blindfold or low vision simulator to develop an awareness of:

- Interpreting traffic sounds to identify the onset of the WALK interval
- Strategies used by pedestrians with visual impairments for locating a pushbutton

A few participants will cross the street while riding in a wheelchair to develop an awareness of issues involved in activating a pushbutton, then crossing the street.

Introduction

Introduction Pedestrians who are blind or visually impaired use different information to make street crossing decisions than that used by sighted pedestrians. Using traffic sounds to find the street, to determine when to cross, and to walk straight to the opposite corner may not work effectively at modern, complex signalized intersections. Pedestrians with mobility impairments and cognitive disabilities have different access issues at signalized intersections.

It is helpful for the engineers who design intersections and determine signalization phases and timing plans to be aware of the needs of and travel strategies utilized by pedestrians with disabilities.

Blindness and Vision Loss

Prevalence of blindness and vision loss

Some degree of *vision impairment* affects 8.3 million (3.1%) Americans of all ages (Adams, Hendershot, & Marano, 1999).

Approximately 3% of individuals age 6 and older, representing 7.9 million people, have difficulty seeing words and letters in ordinary newspaper print even when wearing glasses or contact lenses. This number increases to 12% among persons age 65 and older (3.9 million) (McNeil, 2001). Approximately 1.3 million Americans are *legally blind*.

By 2010, projections are that there will be 20 million visually impaired persons over age 45.

Source: Barlow, Bentzen, & Tabor, 2002

Blindness and Vision Loss

Definitions

Visual Impairment: a functional limitation in seeing, ranging in level of severity from those who can only see large objects with good contrast from close distances to those who have difficulty seeing words and letters for reading tasks.

Legal Blindness: a level of visual impairment that has been defined by law to determine eligibility for benefits.

Legal blindness is defined as:

- Central visual acuity of 20/200 or less in the better eye with the best possible correction (as measured on a Snellen vision chart)

OR

- A visual field of 20 degrees or less

Vision correctable to 20/20 acuity with at least a 180-degree field is considered “normal”.

A person with 20/200 acuity sees at approximately 20 feet what a person with normal vision sees at 200 feet or more. A person who meets the field limitation for legal blindness sees no more than a 20-degree field without scanning.

There is a wide range of visual functioning within the population of persons who are legally blind. Some persons who are legally blind may travel without a long white cane, relying mostly on visual cues to direct their travel. Others may use a cane only at night or in other situations with low lighting. Some persons rely upon a long cane and tactile and auditory cues to direct their travel. It is important to remember that pedestrians who are legally blind are a diverse group in regards to their ability to see crosswalks, vehicles, and signage.

Types of Vision Loss

General types of vision loss

General types of vision loss:

- Total blindness or light perception
- Reduced acuity
- Restricted fields (central or peripheral)

Some eye diseases or conditions cause both a reduced acuity loss and a restricted field.

Reduced acuity can refer to a large range of functional vision from vision tested as less than 20/20 to totally blind. Lighting and contrast affect functional vision and are not reflected in clinical measurements.

Total blindness or light perception

Individuals who are considered totally blind usually cannot see any difference in light and dark. Individuals who have light perception may be able to tell if it is dark or light and the direction of the light source, but do not have vision that is usable for discerning objects or the travel path.

These persons use auditory and tactile cues to identify a street and to make street crossing decisions.

Types of Vision Loss

Normal Vision

Pedestrians with normal vision can see vehicles, other pedestrians, crosswalk lines, the destination corner, and pedestrian signal heads. They can scan the intersection quickly to look for turning cars and use the WALK sign to know when to start crossing the street.

This is the view of a crosswalk as seen by a person with normal vision, i.e. 20/20 acuity and a full visual field.

The photographs in the next sections depict persons with vision loss viewing the same cross walk.

Reduced Acuity

Reduced acuity

Acuity refers to the clarity of vision and the ability to see/identify different size objects at various distances. Clinical acuity measurements are obtained indoors in a setting with controlled lighting. All person's ability to see outdoor travel paths and objects in that path is affected by lighting and contrast.

The ability to see and to recognize objects such as the curb, crosswalk lines, pedestrian signals, vehicles, etc for travel tasks, is highly dependent upon

- The size of the object being viewed and its distance from the person;
- amount, type, and position of lighting;
- contrast between the object being viewed and its background; and
- glare.

One equation used to describe this is:

Visibility = size & distance + illumination + contrast – glare

Persons with visual impairments may experience an increased level of variability in their ability to see objects in the outdoor environment due to implications of their eye disease, fatigue, and other factors.

Mobility Implications

Thus, a person with a visual acuity loss may function quite differently on sunny days versus cloudy days or in well lit versus dimly lit areas.

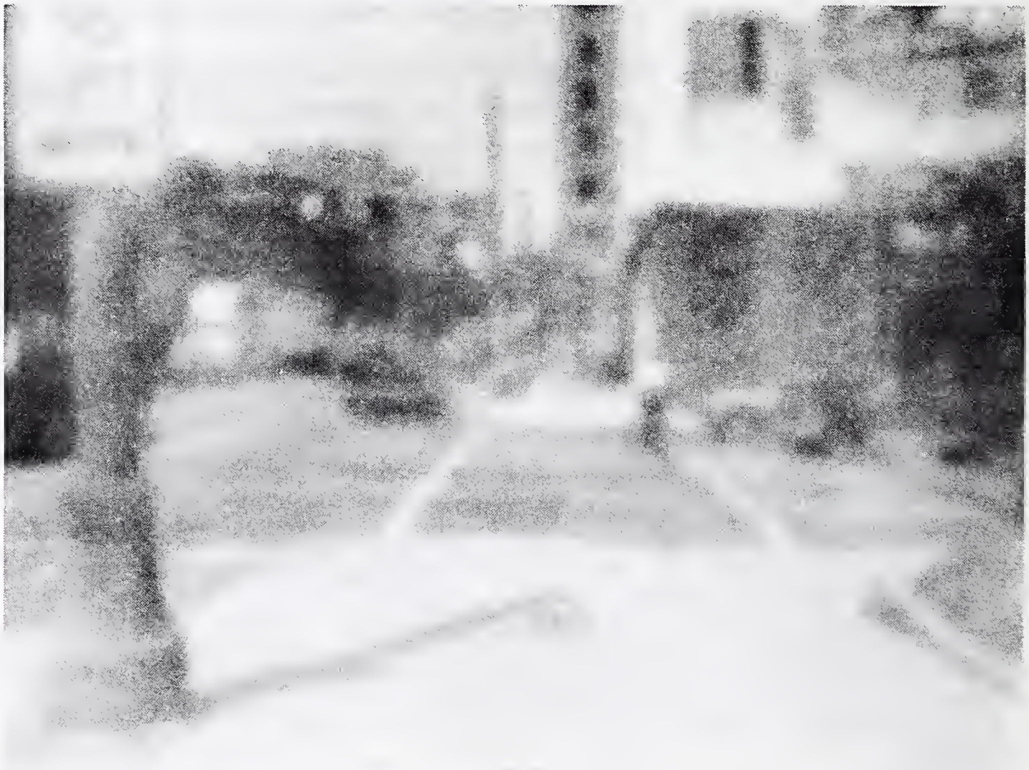
Examples:

- A Person with a visual impairment looking at a pedestrian signal head with the sun behind it may not be able to identify WALK under these conditions, but can identify WALK on cloudy days or at night.
- A Curb that is painted bright yellow would be easier to see than a curb that is the same color as the sidewalk, as the painted curb has increased contrast.

Reduced Acuity

Street crossing view

The photograph below represents a street crossing as a person with general reduced visual acuity might see it.



An overall loss of acuity, increased sensitivity to glare, and loss of contrast sensitivity is common in the elderly population.

Restricted Fields

Different categories of field loss

The general category of restricted fields can be further divided into:

- Central field loss – unable to see things directly in front
- Peripheral field loss – problems seeing things off to the side, above, and/or below
- Hemianopia – inability to see in one-half of the field of vision in one of both eyes

Central field loss

Individuals with a central field loss usually will have difficulty reading signs and seeing details of objects directly in front of them.

Central field loss is typical of macular degeneration, the leading cause of blindness in those over age 60.

Restricted Fields

Central field loss street crossing view

The photograph below represents the same street crossing as a person with a central field loss might see it.

Peripheral field loss

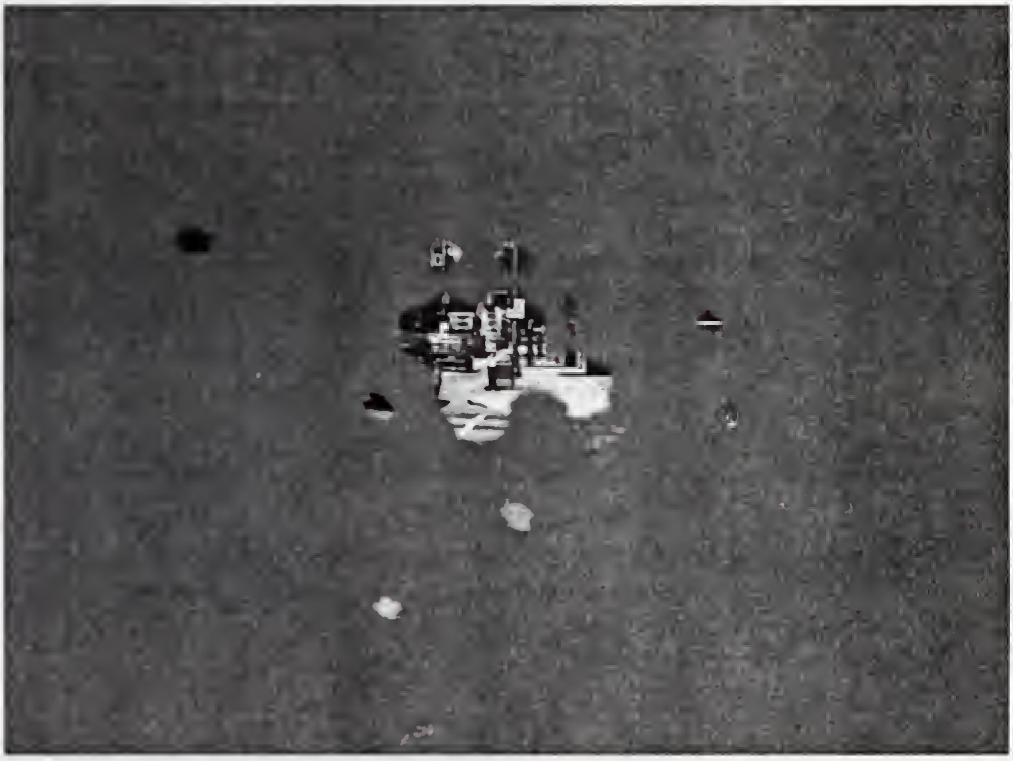
Individuals with peripheral field loss, sometimes referred to as tunnel vision, may see details directly in front of them clearly, but have difficulty seeing objects and signs off to the side. In addition, depth perception, or the ability to see changes in the level of the walking surface, is often impaired.

Glaucoma and Retinitis Pigmentosa (RP) are the main causes of peripheral field loss.

Restricted Fields

Peripheral field loss street crossing view

The photograph below represents the same street crossing as a person with a peripheral field loss might see it.



Hemianopia

Individuals with hemianopia, usually resulting from traumatic brain injury or stroke, may fail to see drop-offs, poles, or other objects to one side of mid-line. Although persons with hemianopia are able to scan to see objects on the affected side, neglect of information on the affected side is common.

More Information about People with Visual Impairments

Area of residence

People who are visually impaired or blind do not all live in the same area of town or same type of area.

Most persons who have a vision impairment live in metropolitan areas (70%), but they are less likely to live in metropolitan areas than are persons without visual impairments (78%) (Schmeidler & Halfmann, 1998b; based on 1994 NHIS-D).

33% live in cities, 37% live in suburbs, 28% live in non-metropolitan areas (e.g., small towns) and 1% live in farm areas (Schmeidler & Halfmann, 1998b).

In comparison to the general population, persons who are visually impaired are over-represented in cites and non-metropolitan areas and somewhat under-represented in the suburbs (i.e., 48% of general population live in suburbs) (Schmeidler & Halfmann, 1998b).

Source – Barlow, Bentzen, & Tabor (2002) *APS Synthesis Draft*

Concomitant disabilities

Some persons with visual impairments have other physical, cognitive, emotional, or sensory impairments.

- Concomitant disabilities may affect the individual's ability to travel outdoors and to cross streets at signalized intersections independently.
- The largest population of persons with visual impairments is persons age 65 and older. Many of these individuals have other impairments such as age-related upper frequency hearing loss.

Travel abilities vary

Some pedestrians with visual impairments travel independently along familiar routes they have memorized through instruction and repeated practice along these specific routes. Other pedestrians travel to new neighborhoods and cities throughout their region and beyond. They expect the same freedom of movement that pedestrians without disabilities have. It is important to note that many persons with visual impairments do NOT receive Orientation and Mobility instruction at all intersections they use.

How People Who are Visually Impaired or Blind Travel

Several choices

People who are blind or visually impaired have choices when it comes to traveling within the community. At any time, they can travel using any of these:

- Human guide
- Long, white cane to identify and avoid obstacles
- Dog guide
- Special optical or electronic aids, or
- Not using a travel tool or aid

The choice of tools depends on the extent and nature of visual impairment, personal preference, lighting, and familiarity with the area.

In order to travel independently, people with visual impairments use whatever vision they have, auditory and tactual clues, and other information they know about an area to keep track of their location and to make travel decisions. Many persons receive mobility instruction from an Orientation and Mobility (O&M) specialist.

Sighted guide

At one time or another, most blind people will rely on sighted (human) guide technique in some travel situations.

- A sighted person serves as a guide to a person who is blind.
- A person who is blind holds onto the guide's arm.

Long white cane

Many individuals who are blind or visually impaired use a long white cane as a mobility device. O&M Specialists teach cane skills.

- In the most common technique, the cane is extended and swung back and forth on the ground across their body width in rhythm with their steps to provide information about the environment in front of them.
- The cane detects obstacles and level changes in the person's path of travel.

How People Who are Visually Impaired or Blind Travel

Dog guide	Dog guides are carefully trained service animals used as travel tools by less than 10% of people who are blind. • The dog responds to commands of its handler, such as right, left and forward. • Dog guides move only in response to directions from their handlers. The handlers must make decisions about the proper time to begin a street crossing and know where they're going. • Dog guides MAY disobey commands to avoid danger.
Low vision aids	Persons with some usable vision may use • sunglasses and visors to reduce glare; • telescopes to magnify signage and other information viewed from distances; and • hand held lights, and other low vision aids for outdoor travel purposes.
No aid or travel tool	Not all persons considered blind use a long white cane or dog guide. People who are visually impaired often rely on their remaining sight and auditory and tactile cues in their surroundings for orientation and travel.

Orientation and Mobility (O&M) Instruction

What is Orientation and Mobility?

Many visually impaired pedestrians have received orientation and mobility (O&M) training, provided by an Orientation and Mobility Specialist (O&M specialist). O&M specialists usually have an undergraduate or graduate degree in teaching travel skills to persons who have visual impairments.

Orientation is the ability to understand where one is located in space and Mobility is being able to travel thorough that space safely. The goal of most O&M training is to prepare a person who is visually impaired to travel in a variety of environments. Individuals are taught strategies used to assess new intersections and to travel unfamiliar routes. Instruction is individualized and geared toward each person's abilities and travel needs.

The profession of O&M was started when veterans who were blinded in World War II returned home needing to learn to travel without sight. O&M techniques and strategies for crossing streets at signalized intersections were developed at a time when intersections were two streets which crossed at perpendicular angles and had fixed time traffic controls. Thus, both O&M specialists and persons with visual impairments that received their training many years ago may be unfamiliar with the concepts of and travel techniques used at actuated intersections.

Orientation is not provided to blind people for every route they need to travel. Many people who are legally blind have not received O&M instruction because they not know this instruction exists, they may not understand the benefits of O&M instruction, or there may not be an O&M specialist in their area due to the shortage of O&M personnel.

Orientation and Mobility (O&M) Instruction

Working with O&M specialists

Traffic engineers are encouraged to work with O&M specialists in their area to learn more about the travel needs of persons with visual impairments and blindness.

O&M Specialists can provide consultation on

- plans for new construction of intersections;
- schemes for prioritizing for APS retrofits; and
- APS installation decisions.

O&M Specialists can also provide

- assistance in publicizing the existence and location of APS installations; and
- information to consumers on how to use APS devices.

Refer to Module 1 for O&M certification information

O&M Specialists may work with pedestrians who use dog guides. Pedestrians who use dog guides are called handlers. O&M Specialists may orient handlers to a new route, intersection, or area. However, O&M Specialists do NOT teach persons who are blind and visually impaired how to use a dog guide. This instruction is taught by Dog Guide Instructors. A small number of Dog Guide Instructors are also trained as O&M Specialists.

MUTCD

The MUTCD 4E.06 states the Orientation and Mobility specialists might be able to provide a wide range of advice in the area of APS. The MUTCD also says that local organizations who provide support to pedestrians with visual and/or hearing impairments can “often act as important advisors to the traffic engineer when consideration is being given to the installation of devices to assist such pedestrians.”

Orientation and Mobility (O&M) Instruction

Finding O&M Specialists

There are several organizations that can assist traffic engineers in locating certified O&M Specialists in their area.

Contact the Association for Education and Rehabilitation of the Blind and Visually Impaired (AER), a professional membership organization at www.aerbvi.org or (703) 823-9690. The Orientation and Mobility (O&M) Division of AER has an Environmental Access Committee (EAC). EAC members are O&M Specialists with interest and specialized training in APS and other environmental access issues.

The Academy for Certification of Vision Rehabilitation Professionals (ACVREP) maintains a directory of certified O&M Specialists (COMS). www.acvrep.org

Contact Dr. Ron Ferguson, Chairman of the National Blindness Professional Certification Board at ferguson@lcb-ruston.com for a list of persons who have National Orientation and Mobility Certification (NOMC).

Instruction in the Use of Dog Guides

Use of dog guides

Dog guides have been assisting pedestrians who are blind in travel tasks for over 70 years. Dog guides lead persons around obstacles in the path of travel and stop or hesitate at level changes.

Dog guide instructors prepare dogs to work as guides and teach persons who are blind how to travel with a dog guide. A person who is blind attends 3-4 week long training sessions or classes at a dog guide school. The individual, referred to as a “handler”, lives at the school during this time. Most dog guide schools set a minimum age of 16-18 years of age for handlers.

Responsibility of the person who is blind (handler) is to

- maintain orientation, knowing where s/he wants to go and how to get there;
- give commands and directions to the dog (such as forward, left, right, go faster, or halt);
- make street crossing decisions; and
- use consistent handling techniques for commands, praise and correction.

Responsibility of the dog:

- Negotiate handler around obstacles in the directed path safely.
- Refuse commands (intelligent disobedience) that place the dog and its handler in danger.

The pedestrian and dog guide team is referred to as a “unit.”

Instruction in the Use of Dog Guides

Street crossing procedures

Alignment:

The handler must align himself and the dog prior to crossing. Although the dog walks generally straight to the destination corner, pedestrians who use dog guides may still have veering problems. While a good dog should be able to compensate somewhat for slightly incorrect alignment, very few dogs will compensate for gross alignment errors. The likelihood of veering increases when the handler is uncertain about the direction of the destination corner.

Knowing when to cross:

The handler makes the decision about when to cross the street. When the decision to cross is made, a "forward" command is given and the unit proceeds to cross the street. In some instances, the dog will disobey a command that puts its handler in danger. This does NOT mean the dog keeps its handler safe at all times. Handlers who make poor decisions frequently will confuse their dog guides. This may cause serious problems for the unit.

Dog guide instructors

Dog guide instructors and O&M Specialists are not the same discipline. Generally, dog guide instructors are trained under apprenticeship programs for 3 years under careful supervision of experienced instructors at the dog guide schools that employ them. They teach adults the techniques used for traveling with a dog guide. Dog guide instructors do not teach cane skills.

Handlers often have had previous instruction from an O&M Specialist.

Finding dog guide instructors

Traditionally, dog guide instructors are not accustomed to consulting with traffic engineers. We hope that networking between these two professions will increase.

A list of dog guide schools can be found at the American Foundation for the Blind (AFB)'s website at www.afb.org under Directory of Services, Dog Guide Training. Currently, there are 14 dog guide schools in the United States and Canada.

How People with Visual Impairments Cross Streets

Video

Video of a person who is blind using a long cane crossing the street depicts:

- approaching intersection and locating street;
- finding and pushing pedestrian pushbutton; and
- aligning self to cross, then crossing using traffic sounds.

Video clip of person veering during street crossing.

Mobility techniques

According to Barlow, Bentzen & Tabor (2002) "Techniques and cues used in crossing streets are diverse and vary by the type of location and by the individual and his or her level of vision and travel aid. Individuals who are blind and visually impaired often travel to unfamiliar areas and intersections and gather information from available sources."

Detecting the street

The first information needed by pedestrians who are blind is: **"Have I arrived at a street?"** People who are blind or visually impaired use a combination of cues to recognize the street edge. These may include:

- Curb or the slope of the ramp
- Presence of detectable warning at the bottom of the curb ramp
- End of building line, cross wind, and open sound of the intersection
- Sound of traffic stopped on the street beside them (the parallel street)
- Sound of traffic on the street they are approaching (the perpendicular street)
- Presence of pedestrians at corner
- Presence of an intersecting sidewalk
- For those with low vision, seeing a color change between the sidewalk and street or a painted curb or curb ramp

Sometimes persons who are blind cannot detect streets due to curb ramps that blend into the street, causing them to unknowingly walk into the street. (Bentzen & Barlow, 1995)

How People with Visual Impairments Cross Streets

Identifying the street

"The next information needed for decision-making at unfamiliar intersections is to confirm: "**Which street is this?**"

- This information is only occasionally provided in any accessible format.
- Pedestrians who are visually impaired develop a mental map and keep track of where they are within that map, usually by counting blocks and street crossings.
- Where necessary, and available, assistance may be sought from other pedestrians."

Barlow, Bentzen, & Tabor (2002). *APS Synthesis.*

Analyzing intersection geometry

"The next information needed is: "**What is the geometry of this intersection?**" including:

- Is my destination curb straight in front of me, or must I angle to the left or right to reach it?
- How many streets intersect here?
- How wide is this street?
- Should I expect to encounter any islands or medians as I cross this street?
- Am I standing within the crosswalk?

Incorrect or missing information for any of these questions may result in missing the destination curb or median."

Barlow, Bentzen, & Tabor (2002). *APS Synthesis.*

At many intersections pedestrians who are blind can determine all but the existence of medians by listening carefully to traffic sounds. However, when there is insufficient traffic movement or when it's too noisy to hear any traffic movements beyond the nearest lanes, this is not possible.

How People with Visual Impairments Cross Streets

Aligning self to cross

The next information needed is: “ **Am I facing directly towards my destination corner?** In many instances, persons who cannot see the crosswalk use the following cues to align themselves prior to crossing:

- Movements of traffic on the parallel street
- Tactile cues on the walking surface
- Mental projection of a straight line of travel in same direction as the line of direction used to travel down the block

It is easier to establish a heading toward the destination corner under these conditions:

- The intersection is 2 streets that cross at a perpendicular angle
- The crosswalk is parallel to the street beside the pedestrian
- There is a steady flow of through traffic on the street parallel to the pedestrian
- There is a single curb ramp oriented in the same direction of travel as the crosswalk

How People with Visual Impairments Cross Streets

Analyzing the traffic control system

Next, pedestrians with visual impairments need to **identify the type of traffic control system** at this intersection.

- Is this a signalized intersection?
- Do I need to push a button to actuate the WALK interval? If so, where is the button?
- Does the signal stop traffic on one street, or all traffic?
- Do cars still turn during the WALK interval? If yes, can they turn left or right or both ways to enter the crosswalk while I am crossing?
- Will I be able to identify the surge of parallel traffic telling me the WALK interval has begun and can I hear it reliably?
- Does this crossing have cars turning right on red?
- Does this intersection have an unsignalized slip lane, requiring me to detect a gap in order to cross to a splitter island before crossing at the signalized crosswalk?

Techniques used by pedestrians who are blind for gathering this information include:

- listening to traffic patterns through several light cycles; and
- searching the sidewalk area for poles with pushbuttons.

Pedestrians need to understand the type of traffic control in order to make good judgments about what timing strategy they will use when crossing a street. Determining the signal timing plan and phases has become difficult or impossible at many intersections because of inability to hear the necessary traffic sounds. Incorrect or missing information for any of the above questions may result in failure to use the pedestrian pushbuttons and crossing at times other than the pedestrian phase.

Barlow, Bentzen, & Tabor (2002). *Accessible Pedestrian Signals.*

How People with Visual Impairments Cross Streets

Using pedestrian pushbuttons

After determining they need to use a pedestrian pushbutton, the next information needed is "**Where is the pushbutton and what crosswalk is it for?**" Pedestrians who are blind need to figure out:

- Is the button close enough to the crosswalk that I will have time to push it then walk back to position myself correctly at the crosswalk, before the onset of the WALK interval?
- Which button controls the WALK interval for the street I want to cross?
- If the button is an APS, how does the device work? What information will it give me?
- Is there a second button on the median that I must push?

If the person is unaware that the crosswalk is actuated by a pedestrian pushbutton, he may not cross during a pedestrian phase, therefore increasing his safety risk. In this instance, there is an increased likelihood of not making it across the entire street before the traffic signal changes to steady green for opposing traffic.

How People with Visual Impairments Cross Streets

Identifying the WALK interval

"After determining the geometry of the intersection, aligning to face towards the destination curb, determining that the intersection is signalized, and having pushed a button, where necessary, pedestrians who are blind need to know: "**When does the WALK interval begin?**"

In the most common technique utilized for crossing at signalized intersections, pedestrians who are blind begin to cross the street when there is a surge of traffic on the street parallel to their direction of travel."

Barlow, Bentzen, & Tabor (2002). *APS Synthesis.*

In absence of an APS, it is often easier to detect the WALK interval under these conditions:

- There is a steady traffic flow on the parallel street at the intersection
- There is a lot of through traffic close to and moving in the same direction as the pedestrian
- At intersections with NO right turn on red
- Fixed time intersections

How People with Visual Impairments Cross Streets

Maintaining crossing alignment

Once the pedestrian who is blind has begun to cross the street, the next question is: "**Am I continuing to head straight towards my destination curb or am I veering?**"

Veering means that the pedestrian changes his direction. Veering may result in the pedestrian walking outside the crosswalk area. The pedestrian may inadvertently walk into the parallel street or beyond the inside crosswalk line.

- Traffic going straight ahead on the parallel street provides helpful auditory guidance to many persons if it is present. Blind pedestrians may also use traffic waiting on the perpendicular street as a partial alignment cue.
- Turning traffic can make it difficult to hear and to align with the traffic traveling straight through the intersection.
- Absence of traffic on the parallel street increases the likelihood of veering.

It is easiest to walk straight to the destination corner if there is a steady traffic flow on the street beside the pedestrian and the vehicles move in a direction parallel to the crosswalk.

Street Crossing Problems Reported by People with Visual Impairments and O&M Specialists

Old techniques are no longer adequate

The above techniques may be sufficient to determine the onset of the WALK interval and the direction of the crosswalk at some types of intersections. They were developed when most intersections contained two streets that crossed each other at perpendicular angles, traffic signals were fixed time, the sidewalk and street were separated by a curb, and right turn on red did not exist.

As intersection geometry and traffic control systems have changed, these traditional techniques are no longer adequate at some types of intersections.

Key research

Surveys of blind pedestrians and orientation and mobility specialists

In 1998, the American Council of the Blind (ACB) and the O&M Division of the Association for Education and Rehabilitation of the Blind and Visually Impaired (AER) conducted surveys having similar questions to determine what problems were experienced by blind pedestrians during street crossings. (Barlow, Bentzen, & Tabor, 2002)

- ACB survey (Carroll, J. & Bentzen, B.L. 1999) – surveys administered orally, in groups, to 158 pedestrians who are visually impaired
- AER O&M Division survey (Bentzen, B.L., Barlow, J.M. & Franck, L. 2000) – mailed to 1000 orientation and mobility specialists, 349 surveys returned

Crossing with and without APS (Talking Signs®)

In research by The Smith-Kettlewell Eye Research Institute (SKERI) in 1997, (Crandall, W.F., Bentzen, B.L., & Myers, L. 1998; and Crandall, W.F., Bentzen, B.L., Myers, L. & Brabyn, J. 2001), 20 blind participants made a total of 80 crossings at 4 fixed-time signalized intersections in downtown San Francisco, both with and without Talking Signs®. The data on crossings without Talking Signs® indicate problems experienced in the absence of APS.

Street Crossing Problems Reported by People with Visual Impairments and O&M Specialists

Hard to find the crosswalk	"On 19% of street crossings in SKERI research, participants requested assistance in locating the crosswalk. Note that they were permitted to begin a crossing from any location that satisfied them, whether or not it was actually within the crosswalk lines. It is common for pedestrians who are blind, if they do not need to locate and push a button, to cross from the position at which they have first encountered the curb line." Source: Barlow, Bentzen & Tabor (2002)
Hard to detect islands	In the ACB survey, 85% of respondents indicated that unexpected features such as medians or islands sometimes confused them. (Barlow, Bentzen, & Tabor, 2002)
Hard to identify shape of intersection	On 54% of crossings in SKERI research, blind pedestrians did not know whether the intersection they had just crossed was a regular 4-way intersection or a "T"-shaped intersection. Blind pedestrians need to understand the shapes of intersections they are crossing because intersection geometry is a good predictor of the probability of the volume and direction of turning traffic. (Barlow, Bentzen & Tabor, 2002)
Hard to determine type of traffic control	In 50% of trials on the SKERI research, participants were not able to obtain sufficient information from traffic sounds and other clues to identify whether an intersection was signalized or had stop signs. (Barlow, Bentzen & Tabor, 2002) Pedestrians who are blind need to understand the type of traffic control in order to make good decisions about what timing strategy they will use to initiate their street crossings.

Street Crossing Problems Reported by People with Visual Impairments and O&M Specialists

Problems with pushbuttons

In the ACB and O&M Division of AER surveys, many respondents indicated that they or their students had difficulty with pushbuttons. ACB - 90; AER – 94%

- They could not tell whether or not they need to push a button.
- They were unable to locate pushbuttons in unusual places.
- They could not tell which crosswalk was actuated by the button.
- The pushbutton was too far away from crosswalk so there was not enough time to push the button and align self at crosswalk before onset of WALK interval.
- They found traveling between pushbutton and crosswalk throws off alignment.

Problems with establishing correct heading

These problems are reported to impede establishing the correct heading (initial alignment):

- Diagonal crosswalks
- Apex curb ramps may direct some pedestrians toward the center of the intersection
- Insufficient traffic to use for alignment or no straight through traffic to cross the top of the T at T shaped intersections

Barlow, Bentzen, & Tabor (2002) report that in the O&M Division of AER survey, 66% of O&M specialists who responded indicated that their students sometimes had difficulty establishing a heading toward the destination corner. The most important reasons given were that traffic was intermittent or the intersection was offset. In the ACB survey, 79% of respondents indicated that they sometimes have difficulty figuring out where the destination corner is located.

On 52% of crossings in SKERI research, blind pedestrians were not facing directly toward the opposite corner when they started their crossing; they were facing somewhat toward or away from the center of the intersection.

Street Crossing Problems Reported by People with Visual Impairments and O&M Specialists

Hard to discern WALK interval

According to Barlow, Bentzen & Tabor (2002), in the surveys conducted by ACB and the O&M Division of AER, many respondents indicated that they or their students sometimes had difficulty knowing when to begin crossing: ACB – 91%; AER – 98%

The reasons they had difficulty knowing when to cross were:

- surge of traffic was masked by right turning traffic;
- traffic flow was intermittent;
- intersection was too noisy; and
- surge of traffic was too far away.

In the AER survey, 79% of O&M respondents indicated that blind students sometimes had difficulty determining the onset of the WALK interval at intersections having exclusive pedestrian phasing.

On 24% of trials in SKERI research, blind pedestrians requested assistance in knowing when to start crossing at crosswalks where they did not use APS. In 34% of trials on which they independently initiated crossings, they began crossing during the flashing or steady DON'T WALK.

Street Crossing Problems Reported by People with Visual Impairments and O&M Specialists

Problems maintaining crossing alignment

In surveys conducted by ACB and the O&M Division of AER, many respondents indicated that they or their students sometimes had difficulty traveling straight across the street. ACB – 75%; AER – 97%

Veering

Walking outside the crosswalk during a street crossing could be the result of:

- problems with initial alignment; and
- veering, which means unknowingly changing one's line of direction during the crossing.

Veering is due to the lack of visual environmental cues to direct someone to the destination corner. Instead, the pedestrian who is blind angles toward the parallel street or beyond the inside crosswalk line on the street being crossed (perpendicular street).

The reasons for veering were:

- there was no acoustic guideline (provided by vehicles on the parallel street);
- the street was too wide;
- traffic was intermittent; and
- the intersection was offset.

In 42% of crossings in SKERI research, blind pedestrians did not get to the corner within the crosswalk. In 19% of trials, participants became sufficiently disoriented that they requested assistance in completing their crossing and arriving at the destination corner. (Barlow, Bentzen, & Tabor, 2002)

It should be noted that despite O&M instruction and good intersection design, some pedestrians who are blind have frequent problems with veering outside of the crosswalk during street crossings.(Guth & LaDuke, 1995, 1994) In some instances using the auditory cues provided by vehicles continuing straight through the intersection may reduce veering.

Benefits of APS

Pushbutton integrated APS with locator tones can help resolve many of the problems described above.

Street Crossing Problems Reported by People with Visual Impairments and O&M Specialists

How People who are Deaf-Blind Cross Streets

Persons who are deaf-blind

Persons who are unable to see pedestrian signal heads and vehicles use traffic sounds to make street crossing decisions.

Persons who are deaf-blind, or blind and hard of hearing use different techniques to cross at signalized intersections.

- They may use limited vision or residual hearing to discern the WALK interval.
- They may seek assistance from other pedestrians or drivers through use of various strategies, such as holding up a written card or playing a recorded message asking for help, or calling out for assistance. Locating someone to assist can be challenging, especially in areas with low pedestrian counts.

Benefits of APS

Persons who are deaf-blind may be able to cross streets at some familiar signalized intersections independently using pushbutton integrated APS. This may be possible if the APS is located properly (so the user's hand can rest on the vibrating surface while standing at the crosswalk) and has:

- vibrotactile WALK indication; and
- tactile arrows oriented in the same direction of travel as the crosswalk.

These may also be useful to pedestrians who are deaf-blind:

- Tactile maps (raised schematic showing what will be encountered as pedestrian negotiates the crosswalk)
- Braille street names or signage

Accessible street crossing information can give persons who are deaf-blind increased freedom. APS may enable persons who are deaf-blind to independently cross familiar streets that had formerly been difficult, awkward, or even impossible to cross without undue risk. Some persons who are deaf-blind may chose to use the WALK indication provided by the APS instead of relying upon the assistance of others to know when the WALK signal is lit in order to cross familiar streets. This eliminates the need to wait for assistance.

Street Crossing Problems Reported by People with Visual Impairments and O&M Specialists

People with Disabilities Other Than Blindness

Introduction

This APS curriculum pertains mostly to persons who are blind or visually impaired. APS are designed to provide information to all pedestrians, especially persons who are blind or visually impaired. But APS can also be useful for pedestrians with other cognitive disabilities or mobility impairments.

The intent of this curriculum is not to discuss all issues related to outdoor travel for persons with disabilities other than blindness. Rather, a few key issues relating to street crossings at signalized intersections are included.

Other disabilities

This section will discuss

- persons with cognitive disabilities; and
- persons with mobility impairments.

Prevalence

In 1990, 1.9 million Americans identified themselves as wheelchair users for the U.S. Census. Four million Americans reported having used a support cane for longer than 6 months. (U.S. Department of Commerce, Bureau of the Census, 1994).

It is estimated that 25% of the 43 million Americans with disabilities are individuals with cognitive disabilities.

Street Crossing Problems Reported by People with Visual Impairments and O&M Specialists

Cognitive disability

Cognition relies on complex processes such as perceiving, thinking, knowing, interpreting, memory, learning, and recognition. “Cognitive disabilities can hinder the ability to think, learn, respond, and perform coordinated motor skills.” *Designing Sidewalks and Trails for Access, Part I of II: Review of Existing Guidelines and Practices* Page 23,. (1999).

There are many causes of cognitive disabilities. Some persons are born with developmental disabilities, learning disabilities or mental retardation. Others experience traumatic brain injury or stroke. Others have processing and memory problems caused by a variety of medical conditions.

Some persons with cognitive disabilities may experience

- additional processing time needed for decision making;
- a narrowed attentional field, such that it is difficult to simultaneously attend to traffic coming from multiple directions;
- difficulty in making judgements based on multiple cues;
- apprehension in noisy environments and at busy intersections; and
- distractibility and inability to ignore “ off task” cues such as barking dogs, road construction and young children.

Benefits of APS

In some instances, an APS may assist a pedestrian with a cognitive disability as it provides redundant information in a nonvisual format. Persons who function best by using auditory information may benefit from the information provided by an APS.

Street Crossing Problems Reported by People with Visual Impairments and O&M Specialists

Mobility impairments

Persons with mobility impairments include those who use wheelchairs, crutches, canes, walkers, orthotics, and prosthetic limbs. However, there are many people with mobility impairments who do not use assistive devices.

People who use wheelchairs and scooters often travel much faster than walking pedestrians, especially on level surfaces or downgrades, but they can be slower when traveling uphill. In addition, their stability and control is affected by surfaces with cross-slopes, grades, or rough terrain.

People who use wheelchairs and scooters require properly designed curb cuts, a wider path of travel, firm surfaces, and ample space to turn around and negotiate the environment.

Characteristics

Some persons with mobility impairments may experience:

- slower travel speed than other pedestrians (this often makes it impossible for persons using walking aids or those having limited strength to get across the street before the pedestrian phase ends);
- inability to negotiate level changes and steep up or down grades in the path of travel;
- difficulty making quick movements into and out of streets and in reacting quickly to dangerous situations;
- speech that may be difficult to understand resulting in the need to use alternative methods to communicate needs to other pedestrians;
- limited hand function making it difficult to push small pedestrian pushbuttons;
- difficulty standing or waiting on sloped surfaces;
- difficulty negotiating soft surfaces;
- difficulty or inability to travel during extreme weather conditions such as intense heat or cold, rain, snow and ice; and
- reduced balance, increasing fall risk or reducing stability when negotiating cross-slopes on sidewalks, crosswalks, and at street corners.

Street Crossing Problems Reported by People with Visual Impairments and O&M Specialists

Benefits of APS

In most cases an APS is not a solution to these problems. Rather, other environmental modifications and increased time for pedestrian phases are needed to provide accessibility at signalized intersections.

An APS provides redundant information, allowing the person to focus on the ramp or curb rather than the WALK/DON"T WALK signal.

Travel Instruction

What is travel training?

Travel instruction, also known as travel training, is short-term, one-to-one, intensive instruction designed to teach people with disabilities other than blindness to travel safely and independently in their community, using public transportation, when appropriate. Individuals with disabilities may learn travel skills while following a specific route, typically to a school or to a job site. It must be noted that many persons with other disabilities never receive travel instruction for a variety of reasons.

Travel instructors have an undergraduate or graduate degree in teaching travel skills to persons with disabilities other than blindness or a degree in special education or rehabilitation. Travel trainers work under the direction of travel instructors. Travel trainers do not have a college degree. They often have received "on the job" training from the travel instructors who supervise their work.

The goal of travel training is to teach persons the skills they need to use to travel safely and independently within their communities, including crossing streets and using fixed route transit. Learning problem solving strategies for unexpected events such as a pathway blocked by debris or construction, and a broken lift on a transit vehicle is also part on travel instruction.

Many persons with cognitive disabilities learn specific routes through repeated practice. Travel instructors may help persons with mobility impairments analyze travel paths for environmental barriers. In addition, persons who use wheelchairs may learn how to utilize lifts on transit vehicles. Instruction is geared toward each individual's specific abilities and travel needs.

Working with Travel Instructors

Engineers are encouraged to work with travel instructors to learn more about pedestrians with disabilities other than blindness. Travel instructors can provide engineers with information about intersection design, signage, and suggested accommodations for accessibility in the public rights-of-way.

How People with Disabilities Other Than Blindness Cross Streets

Introduction

Persons with disabilities other than blindness use techniques and strategies for outdoor travel that are as diverse as the individuals who use them, and the types of areas in which they travel. Some individuals travel to new places within and beyond their local communities without any assistance or guidance. Other persons travel only along learned routes. The level of independence an individual obtains may depend upon:

- interest and need to travel for work and leisure activities;
- ability to understand traffic movements and pedestrian movements in order to negotiate intersections;
- availability of accessible private and public transportation;
- physical barriers in the environment.

Some elderly persons experience some of the same challenges as persons with cognitive disabilities, and/or mobility impairments.

Video of person using wheelchair

Video of a person using a wheelchair crossing a street with pedestrian actuation will be shown at the conference. This intersection will have a single curb ramp oriented toward the center of the intersection.

The video will focus on:

- moving to the pedestrian pushbutton;
- activating the button;
- moving to the corner into position for the crossing; and
- going down the curb ramp, across the street and up the curb ramp at the destination corner.

How People with Disabilities Other Than Blindness Cross Streets

Challenges for persons with mobility impairments

Many challenges have been incorporated in the Intersection Challenges – Signalization and Intersection Challenges – Geometric Issues section of this module. A few challenges are highlighted below:

- curbs or level changes between sidewalk and street
- poor quality surface on curb ramp
- steep slope on curb ramp
- curb ramp that has steep cross slope
- curb ramp oriented toward center of intersection that forces pedestrian to move into street with large number of moving vehicles
- broken or uneven surface in crosswalk
- not enough time to get across street during pedestrian phase
- pedestrian pushbuttons in inaccessible location or too hard to depress

How People with Disabilities Other Than Blindness Cross Streets

Line of sight for persons who use wheelchairs or scooters

The seated position of people who use wheelchairs impacts the height of their line of sight, which is important when looking for traffic signals and vehicles. Based on a U.S. Dept. of Housing and Urban Development study (Steinfield E., Schroeder,S., & Bishop, M., 1979), eye level measurements for a person seated in a wheelchair range from 35 to 52 inches.

Visibility at some intersections can be a problem for both persons who use wheelchairs and drivers if

- drivers of vehicles and pedestrians in wheelchairs may not be able to see each other when high profile vehicles such as vans and trucks are parked close to the crosswalk;
- large objects near the corner such as mailboxes, newspaper boxes, large tree trunks, etc. can block the view of both drivers and persons who use wheelchairs; and
- high profile vehicles near or in the crosswalk block a wheelchair user's view of the WALK/DON"T WALK signal.

How People with Disabilities Other Than Blindness Cross Streets

Cognitive disabilities

The skills and strategies used by persons with cognitive disabilities to make street crossing decisions are similar to those used by pedestrians who are not disabled. However, complex intersections may be difficult or impossible for them to understand. Consequently, some individuals with cognitive disabilities need help from family members, caregivers, or other familiar responsible persons in order to cross streets at some intersections. Being unable to cross some streets alone may prevent these individuals from using fixed route transit or traveling to job sites.

Problems faced by some individuals with cognitive disabilities:

- Increased apprehension at busy intersections
- Delays in time needed to process information
- Lack of understanding of WALK signals could create confusion when seeing WALK (or the symbol of a walking man) while at the same time seeing vehicles moving in the intersection
- Uncertainty when beginning to cross and when pedestrian signal changes from WALK to FLASHING DON'T WALK

Many persons with cognitive disabilities must be taught how to cross streets at all intersections along the routes they travel, through repeated instruction with a Travel Instructor. Without travel instruction, some persons may have very limited ability to problem solve when atypical situations occur at or near intersections or during other travel tasks. The unpredictability of actuated intersections can lead to confusion.

Intersection Challenges – Signalization Issues

Reason for challenges

Signal timing is complex, making it difficult or impossible for pedestrians who are blind to detect the WALK interval, especially at pedestrian and vehicular actuated intersections. Intersection geometries are variable. Traffic volumes are heavy, making it challenging for pedestrians with blindness and other disabilities to cross streets.

Pedestrian actuation

Problems for pedestrians who are blind or visually impaired:

Barlow, Bentzen & Tabor (2002) state that "Pedestrian actuation requires the blind pedestrian to locate and push a pushbutton, then cross on the next perpendicular phase, to be assured of having enough time. Blind pedestrians have two types of problems at these locations:

- They have traditionally waited through a light cycle to assess and refine their heading by listening to vehicular trajectories, before crossing at the next pedestrian phase. At a pedestrian actuated intersection, that is not possible because blind pedestrians then have to locate and push the button again (and re-establish their heading).
- At a location with little vehicular traffic, even if pedestrians who are blind know there's a pushbutton and use it, they may not be able to detect the onset of the WALK interval if there is not a vehicle traveling straight ahead on the street parallel to their crossing."

Problems for persons with mobility impairments- pushbuttons:

- Button is not in an accessible location – too high or not next to or on a smooth, level surface
- Button is too hard to push for person with limited mobility and poor hand and finger strength
- Insufficient time to push button, then travel back to curb to align and prepare self to cross

Intersection Challenges – Signalization Issues

Crossing arterials at actuated intersections

Problems crossing major arterial streets for pedestrians who are blind or visually impaired:

- If a pushbutton calls the pedestrian phase on the arterial, pedestrians must know the button is there and be able to locate it and activate it efficiently. Pedestrians have insufficient time to cross if they do not use the pushbutton.
- When crossing a major arterial intersected by a secondary street with little traffic, the intermittent nature of traffic on the secondary street makes it difficult to discern the WALK interval.
- Cannot use vehicles on secondary street for alignment or for assistance in maintaining heading as most vehicles will turn onto arterial

Vehicular actuation

"Vehicular actuation allows the cycle to skip phases, so pedestrians with visual impairments cannot accurately predict when in the cycle the pedestrian phase will begin. Right turn-on-red makes it harder to determine the surge of traffic at the onset of vehicular green on the street parallel to the crossing direction. Blind pedestrians must wait to hear a car traveling straight across the intersection to determine that the light has changed. Thus, they frequently are delayed in starting crossings while they determine that parallel traffic flow has begun."

"In addition, some locations do not include a pedestrian phase. At times when vehicular volume is low, there may not be enough time to cross the street." (Barlow, Bentzen, & Tabor, 2002)

Intersection Challenges – Signalization Issues

Exclusive pedestrian phase

This type of signalization is designed to result in persons crossing when traffic is stopped in all directions. Right turn on red may or may not be permitted. Exclusive pedestrian phases eliminate the traffic surge concurrent with the onset of the WALK interval, thus removing the most reliable cue used by pedestrians who are blind to identify the onset of the WALK interval.

Problems for pedestrians who are blind:

- If there is no APS, they cannot tell when to start crossing, as they can't reliably detect the onset of the WALK interval. Where right turn on red is permitted it may never sound like they have a WALK interval.
- When there is little or no traffic at the intersection, especially when there are NOT vehicles stopped simultaneously on both streets, can't tell if WALK is lit or there is just a lull in traffic. This is difficult, even if the pedestrian knows this is an exclusive pedestrian phase.
- No traffic moving parallel to the pedestrian's crossing direction increases the likelihood of serious veering

Problems for persons with other disabilities:

- None reported

Benefits to persons with other disabilities:

- This type of signal phasing is very beneficial to pedestrians with cognitive disabilities and mobility impairments

Intersection Challenges – Signalization Issues

Leading pedestrian interval

Leading pedestrian intervals (LPI)s are undetectable to pedestrians with visual impairments.

Problems for persons who are blind or visually impaired:

- If there is no APS, by the time they hear concurrent parallel traffic and initiate the crossing it is late in the pedestrian phase. This results in minimal crossing time, with increased likelihood of not finishing their crossing during the pedestrian phase
- Drivers are not expecting pedestrians to initiate crossings late in the pedestrian phase

Problems for persons with other disabilities:

- None reported

Benefits of LPI:

- Leading pedestrian intervals are beneficial to persons with cognitive and physical disabilities who are able to use pedestrian signals as they allow the pedestrian to start crossing before vehicular movements
- These benefits are the same for persons who are blind IF THERE IS AN APS for these crossings
- Many pedestrians, with or without disabilities, may experience less apprehension at busy intersections with LPI

Intersection Challenges – Signalization Issues

Roundabouts

Roundabouts cause access problems for pedestrians with disabilities because they are not signalized. All pedestrians must cross during a gap in traffic. Pedestrians are generally required to demonstrate assertive behavior and to make judgements about traffic speeds and movements in and out of the circular roadway. Roundabouts are often very intimidating for many pedestrians with disabilities.

Problems for pedestrians who are blind or visually impaired:

Research shows pedestrians who are blind

- experience delays in detecting gaps in traffic;
- miss gaps in traffic more often than sighted persons;
- experience the greatest difficulty during heavy traffic times and at roundabouts having more than one lane; and
- at multi-lane roundabouts, pedestrians cannot reliably use stopped traffic as an indication that it is safe to begin crossing.

Persons with mobility impairment:

- Some persons cannot make quick movements into crosswalk
- Movements needed to cross may increase fall risk
- Some persons do not have ample time to cross
- Drivers may interpret hesitation as meaning pedestrian will wait until vehicle has passed

Problems for pedestrians with cognitive disabilities:

- Traffic patterns are confusing. May be unable to interpret the circular traffic patterns, deciding to cross only when there are no vehicles in the roundabout.
- Some persons cannot judge traffic speeds and distances so they are taught at unsignalized crossings to cross only when there are NO vehicles as far as they can see in all directions. There may not be a time when the roundabout has no vehicles, especially under rush hour traffic.

Intersection Challenges – Signalization Issues

Split-phase signal timing

Problems for pedestrians who are blind:

- Difficult to determine which surge on parallel street to use as cue to start crossing. Thus, they may start crossing either before the WALK sign is lit or late in the pedestrian phase.

Left turn phasing

Problems for pedestrians who are blind – Lead Left:

- Pedestrians who are blind may mistake surge of left turning cars (lead left phasing) as the onset of the WALK interval, then start crossing into the path of left turning vehicles

Lag Left Phasing:

Having the left turn phase at the end of the cycle (lag left) is better for pedestrians who are blind because

- this creates an auditory pattern that is much easier for a pedestrian who is blind to interpret, because the cross (or perpendicular) traffic is followed by a strong, easily identified parallel flow;
- pedestrians move with the surge of parallel traffic, getting the most of the way across the street before the left turning vehicles move through the crosswalk; and
- it allows the pedestrian to initiate his crossing in a timely manner.

Intersection Challenges – Signalization Issues

Noisy locations

Problem for pedestrians who are blind or visually impaired:

Loud traffic volumes or loud background noises may prevent pedestrians from detecting the WALK interval or street geometry features. Noisy locations make it

- hard to hear surge of parallel traffic; and
- hard to hear and track movements of particular vehicles.

Sound bouncing off nearby tall buildings and wind can make it difficult to localize sounds.

Problems for pedestrians with cognitive disabilities:

- May make it harder to focus on information relevant to crossing decisions
- May increase apprehension

Late night operations

Problems associated with late night travel for pedestrians who are blind or visually impaired

- Low traffic volumes make it difficult to discern various parts of signal phasing. Can't discern WALK interval.
- Some signal controls change to flashing operations
- Reduced vision (for persons who do have some functional vision)
- Reduced visibility for drivers

Reduced visibility for drivers may also adversely affect pedestrians with other disabilities.

Intersection Challenges– Geometric Issues

Reasons for challenges

Some geometric features make it more difficult for pedestrians with disabilities to cross streets because of

- wide streets, thus long crosswalks;
- variability in shape of intersection or (approaches not at perpendicular angles and crosswalks not parallel to traffic);
- designs intended to move vehicles through intersections more quickly such as wide radius corners, slip lanes with splitter islands, and roundabouts; and
- some curb ramps

Skewed or offset crossings

If traffic does not move parallel to the crosswalk the problems for persons who are blind or visually impaired include

- poor or no parallel traffic cues for establishing initial alignment;
- increased likelihood of veering and not locating destination corner; and
- veering results in pedestrian being in the street for a longer time, which decreases safety.

Very wide streets

Problems for pedestrians who are blind or visually impaired:

- Hard to hear parallel surge from so far away
- Longer crosswalk distance increases possibility for veering

Problems for persons with mobility impairments (who may or may not use ambulatory aids):

- Not enough time to get across street during pedestrian phase if person moves at speed less than 4 feet per second
- May not have the physical stamina to maintain a quick pace for the entire crossing

Problems for person with a cognitive disability:

- May become overwhelmed by the size of the intersection

Intersection Challenges– Geometric Issues

Roundabouts

Roundabouts cause problems because they are unsignalized and their geometry eliminates straight vehicular movements. Signalization problems were covered above.

Due to the circular design, roundabouts cause these problems for pedestrians who are blind or visually impaired:

- The sidewalk that leads to the crosswalk is often hard to find due to lack of standard placement
- At some roundabouts the crosswalk may not be parallel to the flow of traffic
- At roundabouts with wide radius corners, vehicles do not have to slow down to exit the circular roadway
- At multi-lane roundabouts, pedestrians with visual impairments cannot reliably use stopped traffic as an indication that it is safe to begin crossing

Problems for persons with mobility limitations:

- Poorly designed curb ramps or ramps not aligned properly

Intersection Challenges– Geometric Issues

T-shaped intersection

Crossing the top of the T, which is often the busier street, poses these challenges for pedestrians who are blind or visually impaired:

- Poor or no traffic cues for alignment as there are no cars moving straight through the intersection as all vehicles must turn
- Constant flow of turning vehicles in crosswalk (this is also a problem for pedestrians with other disabilities)
- Difficult to locate the crosswalk when traveling along the top of the T, especially if there is low volume traffic on the stem
- Low traffic counts on stem make it hard to discern WALK interval when crossing the top of the T
- High volumes of vehicles turning from the stem to the top of the T also make it difficult to discern the WALK interval

Right turning vehicles may be turning on red. Left turning vehicles may be hard to hear if there are simultaneous heavy volumes of vehicles turning right. This is especially difficult if the parallel street is to the left of the pedestrian.

No pedestrian crossing

At some intersections, pedestrians are prohibited from crossing 1 or more legs. A No Pedestrian Crossing sign is posted and there is not a crosswalk painted on the street for the prohibited crossing(s). This information is not accessible to pedestrians who are blind. In some instances, curb ramps lead pedestrians to streets with crossings that are prohibited.

Problems for persons who are blind:

- Pedestrians who are blind may cross here, unaware that they are not supposed to cross, putting themselves in danger
- Drivers do not expect pedestrians in the street

In some instances, pedestrians must negotiate 3 crossings to get across 1 street. This may confuse a pedestrian with a cognitive disability who has not had travel instruction. It also increases time spent in the street for all pedestrians.

Intersection Challenges– Geometric Issues

High volumes of turning vehicles

Problems for pedestrians who are blind or visually impaired:

- Disrupts crossing alignment
- Make it difficult to discern WALK interval due to right on red turns or lead left turning phase
- Drivers, especially from behind, won't stop or yield to pedestrians and may not see the person's white cane

Problems for pedestrians with other disabilities:

- Drivers won't stop or yield to pedestrians, especially when the disability is not apparent to the driver
- Seeing the WALK sign on, at the same time as seeing many vehicles turning and moving through their crosswalk may confuse persons with cognitive disabilities. The information is conflicting and ambiguous.
- Many individuals with a cognitive disability experience apprehension crossing unless an intersection has little or no traffic. This type of intersection can be overwhelming.
- All persons, especially those who walk using a mobility aid, need a safe interval to cross without rapidly turning vehicles. It is difficult for some persons to make the abrupt stopping and starting movements required to avoid turning vehicles.
- Drivers may not immediately see persons who use wheelchairs or scooters, due to their height

Intersection Challenges– Geometric Issues

Refuge islands

This section refers to islands or medians that are in the crosswalk and intended for pedestrian refuge.

Problems for persons who are blind or visually impaired:

- When standing at the corner to analyze a new intersection, pedestrians who are blind often cannot tell there is an island in the crosswalk
- When crossing, pedestrians who are blind may not be able to find a raised island that does not go across the entire crosswalk width
- Cannot detect islands that are just painted lines on the street
- May unknowingly cross through an island that has a flat cut-through
- May begin to cross or continue to cross during the steady DON'T WALK interval, instead of stopping at the island to wait for the next pedestrian phase

Problems for persons with other disabilities:

- Some islands do not have curb cuts needed by persons who use wheelchairs or other ambulatory aids
- Some persons with cognitive disabilities may experience apprehension when standing in between lanes of moving traffic

Intersection Challenges– Geometric Issues

Channelized right turn lanes

Drivers often do not stop or yield to pedestrians. This is challenging to all pedestrians when the traffic is heavy. It is particularly challenging for pedestrians with disabilities.

Problems for pedestrians who are blind or visually impaired:

- Cannot discern vehicles in right turn lane when traffic is heavy due to difficulty in localizing all cars – too noisy
- May not be able to find crosswalk area and to align self if sidewalk approach does not have a level change
- May hesitate to be "sure". Drivers may interpret their hesitation as indication they will not cross at this time

Problems for pedestrians with mobility impairments:

- Some persons cannot make abrupt movements required to move quickly into the crosswalk. Drivers may interpret their hesitation as indication they will not cross at this time.
- Some persons move at a slow rate of speed, which creates a safety risk as they are in the street for a longer period of time
- Older intersections may not have curb cuts at the island

Problems for pedestrians with cognitive disabilities:

- Persons are frequently hesitant to initiate crossing when a high volume of traffic exists, even when the pedestrian has the right of way. Frequently they will wait until there is no traffic at or approaching the intersection. Crossing the channelized right turn lane may require waiting for extended periods of time for a break in traffic.
- Persons may not understand that free flow right turning vehicles do not have to stop, as these vehicles do not have a signal. Persons may move out in front of vehicles as there is not a DON'T WALK or traffic light to help direct their movements.

Intersection Challenges– Geometric Issues

Curb ramps

Some corners have one curb ramp (shared curb ramp) that is used for two crossing directions. This ramp is at the center of the curb radius and is oriented toward the middle of the intersection (diagonally). Shared curb ramps align the pedestrian out of the crosswalk and potentially into moving vehicular traffic.

Problems for persons who are blind or visually impaired:

- Difficulty aligning to face the destination curb
- May direct person into moving vehicular traffic

Problems for persons who use wheelchairs:

- Person must travel in street with moving vehicles to get to desired crosswalk.
- Person must decrease travel speed to make a turn at the bottom of the ramp. This requires the traveler to exert more effort to travel across the crosswalk.
- When approaching a shared curb ramp after crossing, the person must again decrease travel speed to align with the up curb ramp. With the loss of momentum, additional effort is necessary to climb the ascending grade of the ramp.
- If the curb ramp does not intersect the curb line at 90 degrees, wheelchairs and scooters cannot keep all wheels on the surface as they move on and off the curb ramp. This results in loss of control of the wheelchair or scooter.

(Final Report PROWAAC, 2001).

Experiential Exercise – Analyze Intersections

Purpose

The intent of this exercise to allow participants to collect information through listening to traffic sounds at intersections when their vision is occluded with a blindfold or limited by low vision simulators. Traffic engineers (and those unfamiliar with strategies used to cross streets by pedestrians who are blind) will have the opportunity to listen to the sounds of moving vehicles to collect information about the intersection geometry and type of signalization. They will experience using traffic sounds for alignment to face the destination corner and for determining the onset of the WALK interval.

Some persons may have the opportunity to observe a pedestrian who is blind crossing the street or to speak directly with that person about the strategies used and challenges at the selected intersections.

The intent is not to try to simulate blindness nor to teach engineers to cross streets without sight.

Initial setup and directions

Before dividing into small groups, the participants will learn basic sighted guide position, how to negotiate narrow spaces, and how to approach a curb when guiding a person who is blind. These techniques will be demonstrated, diagrams will be provided, and verbal directions will be given.

Materials

Materials for outdoor exercise are

- blindfolds;
- goggles with lenses to simulate visual acuity loss or funnels to simulate peripheral visual field loss; and
- index cards with questions the guide will ask at the intersection.

Small groups

The participants will divide into 4 groups of 7-8 persons each. The leader of each group will be a certified O&M specialist. The participants will be traffic engineers or persons who are blind or have other disabilities. Participants will be asked to demonstrate basic sighted guide position with their partners as they walk to the building exit in order to help insure that all participants will travel safely to the intersections.

Experiential Exercise – Analyze Intersections

Work in pairs

Each group will be further divided into pairs. One partner in each pair will wear a blindfold or low vision simulator and be guided by the other member of the pair.

First intersection:

1. Four pairs will approach each intersection. Two will be asked to answer questions for the N-S crossing, and the other two pairs will work on the E-W crossing.

2. One person in each pair will approach the intersection while wearing the blindfold. Each pair will complete the tasks at one intersection, change roles, then travel to a second intersection.

Second intersection:

1. The person who was the sighted guide now wears a blindfold or low vision simulator.

2. The pair travels to the second intersection, then complete the tasks again.

Note: for pairs in which one person has a visual impairment, the engineer may guide this person or walk nearby the person as s/he approaches the intersection. The individual who is visually impaired or blind will make this decision. The person who is blind may explain to the engineer how s/he interprets traffic sounds and other environmental cues at the intersection.

Experiential Exercise – Analyze Intersections

Intersection tasks

Two signalized intersections near the conference site will be used with 2 groups at each intersection. At each intersection participants will identify

- the edge of the street;
- stopped and moving vehicles;
- turning cars;
- the number of legs at the intersection and the width of the street they intend to cross;
- the type of traffic control and phases;
- if actuated, find the pushbutton & push it;
- alignment to face the destination curb; and
- the onset of the WALK interval.

The O&M specialists and consumers who are blind will answer questions and tell about the strategies that pedestrians who are blind or visually impaired use to collect information at intersections.

Participants may choose to cross the street with their sighted guide.

Monitoring safety

All participants will have a partner who is responsible for maintaining the safety of the person who has his/her vision occluded or is using a wheelchair. The O&M specialists and travel instructors will closely monitor their groups and intervene as necessary to ensure safety.

Experiential Exercise – Analyze Intersections

Crossing using wheelchair

A few participants will use a wheelchair to cross the street. The leader for this exercise will be a travel instructor. The participants will not have their sight occluded. They will be expected to discuss their experiences with the large group.

- How did the curb ramp affect your approach to the street?
- Describe the location of and the environment around the pushbutton. Was it accessible?
- Was there enough time to push the button, then get back to the corner to align for your crossing before the WALK sign lit up?
- How did the camber of the street affect your ability to move across the crosswalk?
- Were there any environmental barriers that affected the view of oncoming traffic?
- What was the most challenging part about crossing the street?

Experiential Exercise – Analyze Intersections

Discuss experience

The large group will convene to discuss the outdoor experience. Some of the leader's questions:

- How could you tell you arrived at the street?
- How difficult was it to find and access the pushbutton? Did you feel disoriented when looking for the button, then returning to the crosswalk?
- Did you have enough time to push the button, the get back to the crosswalk before the WALK interval started?
- Could you identify turning vehicles?
- How did you know it was time to cross (WALK interval)?
- What was the most difficult part of this exercise?
- Vision loss – could you see the traffic signals? Pedheads?
- How would an APS help for this crossing?

Participants will be reminded that many persons receive O&M instruction to help them learn how to analyze traffic sounds to make street crossing decisions. Some persons can generalize these strategies to new intersections. Others need to be familiarized to an intersection before they use it.

Summary

Pedestrian needs

Pedestrians with disabilities are a diverse group with specific needs. However, improving pedestrian accessibility for this group improves pedestrian accessibility for everyone. Balancing the needs of pedestrians with the need to move vehicles through an intersection quickly in an efficient manner can be challenging for traffic engineers.

As civil rights legislation adds guidelines for the public rights of way and the MUTCD includes more specific guidance on APS, newly constructed intersections will become more accessible for pedestrians with disabilities. These changes will trigger APS retrofits.

Collaboration

Traffic engineers, O&M Specialists, Dog Guide Instructors, Travel Instructors, and pedestrians with disabilities are encouraged to work together to

- make decisions when intersection modifications or APS are requested by consumers;
- learn each other's jargon to facilitate effective communication; and
- consider the needs of pedestrians with disabilities in transportation improvement plans and new construction.

APS as possible solution

Many of the problems experienced at street crossings by pedestrians who are blind may be ameliorated by pushbutton integrated APS with locator tones, such as

- identifying WALK interval at intersections with LPI, exclusive pedestrian phasing, under low traffic or noisy conditions, split phase timing, very wide streets, and others;
- identifying median and splitter islands;
- finding pushbuttons for pedestrian actuated crossings;
- crossing the top of the T at T-shaped intersections with lots of vehicles turning onto the major street;
- crossing at offset intersections, the far corner locator tone may assist with finding the destination corner;
- pedestrians who are deaf-blind crossing familiar streets at which it is difficult to get assistance.

Summary

Research

Chapter 2 of the *APS Synthesis and Guide to Best Practice* (Barlow, Bentzen, & Tabor, 2002) reviews the research literature documenting

- problems at intersections experienced by pedestrians who are blind, that may be ameliorated by the use of APS;
- problems pedestrians who are blind experience with the most common APS in use in the US today;
- the effect of APS features on street crossing by pedestrians who are blind; and
- the effect of APS on general pedestrian and vehicular traffic flow.

This reference also provides information on current APS research projects.

Module 3

Analyzing Existing Intersections for APS Retrofits

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Objectives – Module 3 – Analyze Existing Intersections for APS Retrofits

Objectives lecture & discussion

(35 minutes)

Through discussion and slide presentations, the participant will gain an understanding of:

- Reasons why APS prioritization schemes are necessary
- Review of current regulations regarding APS installations
- Brief review of information needs of blind pedestrians and intersections that may require an APS need evaluation
- Need for collaboration between traffic engineers, pedestrians with disabilities, and O&M specialists (or travel instructors or advocates)
- The components of a model prioritization checklist and procedures for administration

Objectives-indoor experiential exercise

(25 minutes)

Through an indoor small group exercise, participants will:

- Complete a model APS Prioritization Checklist for 2 sample intersections, looking at each crosswalk separately
- Determine which crosswalks need an APS retrofit and the rationale behind the decision

Introduction

Introduction

Regulations pertain only to newly constructed signalized intersections and intersections that are being altered to include new or updated signalization. There are still many signalized intersections throughout the country that are difficult or impossible for pedestrians who are blind to cross.

In making their facilities and street crossings accessible, state DOTs and municipalities must develop a system to:

- Handle requests for APS
- Systematically identify those intersections that need to be evaluated
- Make decisions about where APS should be installed

Because of funding and other issues, it is often necessary to prioritize installations.

Review of Legislation

Section 504 of the Rehabilitation Act of 1973	Requires non-discrimination in federally funded programs. "No qualified handicapped person shall … be denied the benefits of … any program or activity that receives or benefits from Federal financial assistance administered by the DOT" (Barlow, Bentzen, & Tabor, 2002)
Transportation Equity Act for the 21st Century **(1998)**	The Transportation Equity Act for the 21st Century (TEA-21) states that pedestrian safety considerations should be included in new transportation plans and projects. Section 1202 (g) (2) directs that they "… shall include the installation, where appropriate, and maintenance of audible traffic signals and audible signs at street crossings." Requires that FHWA, in concert with AASHTO and ITE, develop guidance on pedestrian and bicycle design and construction.
Americans with Disabilities Act (ADA) of 1990	The Americans with Disabilities Act (ADA) was passed in 1990. ADA is a civil rights law that prohibits discrimination against persons with disabilities. ADA has five parts, with Titles II and III pertaining to public services and accommodations. • Titles II - Public Services (state and local government programs) • Title III - Public Accommodations (public and commercial facilities) Guidelines for implementation of each part were developed by agencies charged with that responsibility: • Under Titles II and III, the U.S. Access Board develops and maintains accessibility guidelines for buildings, facilities, and transit vehicles • The ADA Accessibility Guidelines (ADAAG), issued in 1991, serve as the basis of standards used by the departments of Justice (DOJ) and Transportation (DOT) to implement the ADA

Review of Legislation

ADA and the Public Rights of Way

Although ADAAG does not specifically address the public rights-of-way (PROW)

- This does not absolve municipalities and states from the responsibility to provide street crossings that are accessible to persons with disabilities
- Access to movement on the PROW is considered to be a program provided by state and local governments, and therefore must be accessible under Title II of ADA.

ADA draft PROW guidelines

Draft PROW guidelines, based on the PROWAAC report (see Module 1) were published on June 17, 2002 for public comment. They apply to new construction and planned alterations. These guidelines can be downloaded from the Access Board website: http://www.access-board.gov/news/prow-release.htm

Draft guidelines require APS at

- each crosswalk with pedestrian signal indications; and
- each APS device shall have a signal that includes audible and vibrotactile indications of the WALK interval.

Minimum guidelines and requirements for implementing the ADA in the public rights of way will be issued in a Notice of Proposed Rulemaking in 2003.

Summary

ADAAG does not specifically have a section on public rights-of-way. Upcoming minimum guidelines and requirements in ADA legislation will apply to newly constructed intersections and intersections with planned alterations.

HOWEVER, this does not absolve municipalities and states from the responsibility to provide street crossings that are accessible to persons with disabilities. New construction guidelines have to be applied in a retrofit situation, as much as they can be, without imposing “undue hardship”.

In addition, several years from now when APS are installed at more intersections, persons with disabilities may likely ask for more retrofits as they learn about newer technologies and reap the benefits of APS.

MUTCD Standards & Guidelines

What is the MUTCD?

The MUTCD is a manual published by the Federal Highway Administration (FHWA). It is the National standard for traffic control devices on any street, highway, or bikeway open to public travel.

National standards

All states must conform with the MUTCD standards when installing any traffic control devices. Changes made by FHWA to the MUTCD must be adopted within 2 years, unless otherwise noted in the Final Rule.

The MUTCD specifies required, specifically prohibitive, recommended, and permitted practices regarding a traffic control device. Informational statements of support or guidance are also included.

APS in the MUTCD

The Millennium Edition (MUTCD 2000) was the first edition to include APS. Sections on APS are Part 4E.06, Accessible Pedestrian Signals and Part 4E.08, Accessible Pedestrian Signal Detectors. A list of specific provisions for APS in the MUTCD is included in Module 4.

The MUTCD includes guidance on procedures to be followed for intersections that present problems for persons with visual impairments. These procedures should be used for new construction, alterations, and APS requests for retrofits at existing intersections.

Guidance

If a particular signalized intersection presents difficulties for pedestrians with visual disabilities, an engineering study should be conducted which considers the safety and effectiveness for pedestrians in general, as well as the information needs of pedestrians with visual disabilities. (MUTCD section 4E.06)

This study should consider the following factors:

- Potential demand for APS
- A request for APS
- Traffic volumes during times when pedestrians might be present; including periods of low traffic volumes or high turn-on-red volumes
- Complexity of traffic signal phasing
- Complexity of intersection geometry

Pedestrian Information Needs – Persons who are Blind

Information needs for ALL pedestrians

All pedestrians need to gather information about the crossings in order to make decisions about when to cross and which direction to travel to get to the destination curb. Pedestrians with sight use the color of the traffic signals, the pedestrian WALK and DON'T WALK signals, and stopped and moving vehicles to make these decisions. Persons who cannot see the pedestrian signals and crosswalks must gather this information by listening to the sounds of vehicles at the intersection.

Information needs for pedestrians who are blind

Before making street crossing decisions a pedestrian who is blind must figure out answers to the following questions. This process is done through interpretation of acoustic cues and cognition:

- Have I arrived at the street?
- Which street is this?
- What is the geometry of the intersection?
- Am I permitted to cross here?
- What is the type of traffic control?
- Do I need to find and push a pedestrian button?
- When does the WALK interval begin?
- Am I headed straight toward my destination curb?

Need for APS

If these questions cannot be answered through interpretation of acoustic cues at all times, the crossing should be analyzed for APS. A list of intersection features that make crossings difficult is discussed later in this module and in Module 2B.

Traffic Counts

It is important to remember that too much traffic or too little traf can cause problems with identifying the WALK interval, maintain a straight crossing, and identifying intersection geometry.

For more information

ITE website includes a Toolbox on Accessible Intersections for Pe with Visual Impairments.http://www.ite.org/library/accessibleir

Two of the articles that can be found on this website (Bentzen, Franck, & Barlow, 2000 and Carroll & Bentzen, 1999) provide information on intersection barriers and accessibility for persons who are blind and visually impaired.

Review of Benefits of APS

Universal design

APS have benefits to all pedestrians and drivers. Newer technologies have quieter signals, thus reducing community concerns about noise pollution.

All pedestrians

All pedestrians can benefit from APS because they provide redundant information. APS bring Walk/Don't Walk information from the other side of the street to the nearside (departure point), thereby making it accessible to people who are blind or have low vision. APS are widely used in Europe. This helps

- Locator tones call attention to the need to push a button to actuate a pedestrian phase
- Seniors with diminished sight
- Tourists who are unfamiliar with intersections
- Crossing guards within school zones
- Persons who cannot read the pedestrian signals that use words (instead of newer symbols)
- May move pedestrians through the intersection faster

Persons with disabilities

Specific benefits to pedestrians with disabilities:

- Provides person who is blind with same information available to those who have sight
- At some intersections, virtually impossible for pedestrian who is blind to discern WALK interval without an APS
- APS with vibratory output is only means for person who is deaf-blind to detect WALK interval without assistance
- Persons with cognitive challenges may use APS as most discernable, reliable source of information for making crossing decisions

Pushbuttons with locator tones:

- Call attention to the need to push a button to "call" a pedestrian phase
- Help persons find the button efficiently
- Help persons with visual impairments find the crosswalk if it is in a mid-block or unusual location or situation
- Help persons detect and locate a median or refuge island in the crosswalk, when APS is located on the island

Drivers

The increased exposure to accommodations designed to make intersections accessible to all pedestrians may make persons more aware of pedestrians with disabilities. As most drivers are also pedestrians, they may drive through the same intersections with APS they previously used when walking.

It is believed that APS may increase driver awareness of variability in pedestrian crossing time and needs. The audible tone from an APS may increase driver awareness of the presence of a pedestrian at the corner or in the crosswalk.

Van Houten, Malenfant, and Retting (1997) found that redundant information conveyed by audible pedestrian signals increases the attention of all pedestrians to turning traffic and may contribute to a reduction in pedestrian-vehicular conflicts and crashes at signalized intersections. Their research was conducted in Clearwater, Florida, using prototype speech message technology in which speech messages were broadcast from the pedhead.

Results (Van Houten et al, 1997) indicated that voice messages can be used

- to increase the attention of all pedestrians to turning vehicles; and
- to decrease pedestrian-motor vehicle conflicts at signalized intersections.

Use of Prioritization Schemes for APS Retrofits

Need for prioritization scheme

Current ADA guidelines (ADAAG) do not specifically address APS. However, Title II of ADA requires municipalities to make their "programs" accessible. Pedestrian circulation is considered a program, thus access is a civil right. APS is necessary to ensure information access at some intersections. Municipalities will be expected to identify intersections that are not accessible. Part of this process is to identify street crossings that have insufficient information using non-visual clues.

Thus, municipalities need to develop some type of system to determine where APS need to be retrofitted at existing signalized intersections. Procedures for making decisions about APS retrofits are best served by prioritization schemes, many of which employ prioritization checklists.

What is a prioritization scheme?

Prioritization schemes are documented procedures for determining whether an APS is recommended for existing intersections. The scheme defines a system for handling APS requests and for evaluating existing intersections for the need for APS retrofits.

In many municipalities, the prioritization scheme requires that an engineer and O&M specialist evaluate each crosswalk at an intersection using a prioritization checklist. This checklist is a rating scale that typically includes pedestrian usage, intersection geometry and signalization, traffic volume, safety, and other features of the intersection. Various features are assigned point values.

Use of Prioritization Schemes for APS Retrofits

Benefits of retrofit schemes

Having a well articulated scheme or documented system for prioritizing retrofits benefits municipalities

- Easier for traffic engineer to justify the decision to add an APS if it is based on an engineering study, sound technical reasoning, and support of a consumer, an O&M specialist, dog guide instructor, travel instructor, or service agency (if one is involved)
- Helps ensure devices are installed first where needed most so pedestrian access is enhanced in areas of greatest need
- Communities will install devices only where mandated (at newly signalized intersections or altered signalized intersections)

When APS are installed at newly signalized intersections, awareness of APS will be increased. Many consumers may begin to request APS, which makes the need for an APS retrofit scheme even greater. A scheme for prioritizing retrofits will prove to be fiscally responsible for municipalities.

Current practice in U.S.

APS are typically installed upon request of a pedestrian or a service organization along a specific route of travel at specific intersections for a particular individual or group of individuals who are blind or visually impaired.

Where are APS needed?

Intersections that may require APS evaluation

The following intersection features may require an evaluation to determine if a retrofit APS installation is needed as they pose particular problems for persons who are blind or visually impaired.

Signalization issues:

- Leading pedestrian intervals (LPI)
- Exclusive pedestrian phase, especially where right-turn-on-red is permitted
- Channelized right turn lanes with free flow traffic
- Split-phase signal timing
- High volumes of turning vehicles
- Roundabouts, due to lack of signalization
- Crossing major streets at actuated intersections
- Crossing at intersections with low volumes of traffic on the parallel street

Geometric issues:

- Very wide streets
- Skewed or offset crossings
- Crossing the top of the T at T-shaped intersections
- High volumes of turning cars

Other issues:

- Noisy intersections
- Late night crossings

Refer to Module 2B entitled “Street Crossings at Signalized Intersections for Pedestrians with Disabilities” for more specific information.

Acoustic information is high priority

Sufficient acoustic information must exist, at ALL times, to permit safe crossing at a particular crosswalk. This is a high priority factor, as the information provided by an APS may be needed at any time by residents, occasional travelers, and visitors. In addition, it must be noted that pedestrians with visual disabilities can and do utilize intersections that are unfamiliar to them.

Where are APS needed?

Pedestrian request is high priority	Pedestrian request for APS or request on behalf of a pedestrian should be given serious consideration. The advice of an organization must NOT take precedence over the needs of an individual with a disability. The need of an individual who is not involved with a service delivery organization must not be minimized.
Persons with other disabilities	LPI may benefit many pedestrians, including those who are not disabled. Both the LPI and the Exclusive pedestrian phase (in absence of right turn on red) are beneficial to persons with cognitive disabilities and persons who have mobility impairments. They allow persons to enter the street either before traffic begins moving or to cross when traffic is stopped in all directions. If information is made accessible by an APS, LPI are also beneficial to pedestrians who are blind.
Procedures for APS request	Steps an engineer should take upon receipt of APS request: • Talk to the person about his/her needs and challenges at the particular “problem” crossings • Analyze intersection with person and his/her O&M specialist, dog guide instructor, travel instructor, or representative from agency (if one) • Complete a prioritization checklist at the intersection for every crosswalk in question

Components of APS Prioritization Rating Scales

Rating scales

Over the past 5-10 years, several jurisdictions have developed well-articulated systems for handling APS requests and for evaluating existing intersections for the need for APS retrofits. After a request is made, the intersection is evaluated using a rating scale. Prioritization checklists in the form of rating scales are used by San Diego, Los Angeles, Portland OR and the Maryland Department of Transportation. In Canada, Montreal and Ottawa also use rating scales.

Points are assigned to specific intersection features, as well as for proximity to services for all pedestrians. A minimum number of points must be obtained to earn high priority status for APS installations. Rating scales provide a system for prioritizing where the APS are needed most urgently.

Separate crosswalks

Each crosswalk MUST be analyzed separately as the acoustic information, geometric design, and flow of traffic may vary significantly for crosswalks at the same intersection. At the same intersection, certain crosswalks may be problematic while others have sufficient acoustic information. Thus, different crosswalks at the same intersection may receive high or low scores for APS prioritization.

Pedestrian usage items

Factors in several prioritization checklists currently used in the U.S.:

- Proximity to alternate crossings (farther away from accessible crossing = higher points)
- Proximity to transit stops (more stops within block = higher points)
- Proximity to facility for persons who are blind (closer = higher points)
- Proximity to key facilities used by all pedestrians (closer = higher points)

Components of APS Prioritization Rating Scales

Intersection safety & traffic conditions items

Factors in several prioritization checklists currently used in the U.S. (Gallagher & Montes de Oca, 1998).

Related to Geometry:

- Intersection configuration (offset, major street at 3 leg T, unusual geometry, etc = higher points)
- Width of crossing (wider street = higher points)
- Right turn splitter island

Related to traffic speed, volume and movement patterns:

- Vehicle speed (faster = higher points)
- Traffic volume per cycle -some use surge volume, some look at 6AM-6PM counts (both heavy & very light = higher points)
- Heavy Right turn during pedestrian phase
- Continuous Right turn permitted

Related to pedestrian safety records, pedestrian request & surrounding community:

- Pedestrian accident records from past 3-4 years (1-2 points per accident)
- Pedestrian request or demonstrated need
- * Neighborhood acceptance
- *Existing signal which is susceptible to retrofitting
- * Surrounding land usage

* Barlow, Bentzen and Tabor (2002) have eliminated the last 3 factors. Access to information is a civil right that supersedes public convenience and financial considerations. Also, newer APS technologies allow for quieter signals and easier installations.

Components of APS Prioritization Rating Scales

Signalization items	These types of signalization are particularly challenging to persons with visual impairments and blindness. They should also be included in prioritization schemes (Gallagher & Montes de Oca, 1998; Barlow, Bentzen, & Tabor, 2002) • Leading pedestrian interval • Exclusive pedestrian phasing (more points if right-turn-on-red permitted) • Split phasing • Phasing that has a lead or lag left turn • Presence of pedestrian pushbutton (actuation) • Full vehicular actuation • Semi-actuated, crossing the major street
Special conditions	Used in current checklists by municipalities in U.S.(Gallagher & Montes de Oca, 1998). • Poor visibility of pedestrians (obstructions, parking lanes, curved street, crosswalk location) • Orientation and Mobility Specialist comment/evaluation Bentzen & Kolb checklist adds acceleration lanes.
Research on a rating scale	As part of NCHRP Project 3-62, a prioritization rating scale is being validated. After project completion, the rating scale/checklist will be available for use by municipalities involved in prioritization decisions.
NCHRP Project 3-62 rating scale	This prioritization scale is considered the model for best practice.

Decision Making Process for Retrofits

Persons involved

In most municipalities, the following persons are involved in the decision for an APS retrofit:

- Traffic engineer
- O&M specialist or other travel training professional
- Pedestrian with disability who made APS request

This project supports dog guide instructors and travel instructors also being involved. They may meet at the intersection in question.

Some communities seek input from residents and business owners through public meetings, newspapers, and organizations that serve consumers with disabilities. This information may be useful for engineers for deciding what type of APS to install. However, engineers should NOT use community input to decide whether or not to install an APS. Remember, the advice of an organization should NOT take precedence over the needs of an individual with a disability who requests an APS.

Jurisdiction procedures for intersection evaluation

Different persons in different jurisdictions conduct the intersection evaluation:

- San Diego, CA – a traffic engineer and an O&M specialist rate separate aspects of the intersection
- Los Angeles, CA and Portland, OR – rating conducted jointly by O&M specialist and traffic engineering department
- Maryland – DOT engineer determines the rating

Prioritizing based on ratings

In San Diego and Portland, an advisory committee that assists the traffic engineering department with prioritization of installations reviews the ratings. Intersections with the highest number of points are generally considered highest priority. However, the date of request, plans for other construction at the intersection in question, and other issues may affect the priority of the installation. (Barlow, Bentzen, & Tabor, 2002).

Small Group Exercise – Use Prioritization Checklist

Purpose

To analyze two sample intersections by using the NCHRP Project 3-62 Prioritization Checklist. Participants will identify which crossings need an APS retrofit and the rationale behind their decisions.

Participants in small groups

Divided into 10 groups of 6 persons. Each group will have 3 engineers and 3 persons knowledgeable about blindness or other disability issues (O&M specialists, dog guide instructors, travel instructors, or consumers).

Materials

For each intersection, participants will be given:

- Diagram
- Photograph(s)
- Description of entire block and nearby area including:
  - nearby facilities
  - transit stops – location and number
  - proximity to "good" alternative crossings
- Traffic information - volumes
- Signal phasing information
- Pedestrian count

Sample intersections

5 groups will work on Intersection #1 and 5 groups will work on Intersection #2. Intersection descriptions:

- T intersection, lots of traffic on the arterial street, little traffic on the minor street
- Four-way (+shaped) intersection with complex signal phasing, including free flow right turn lane

Discuss results

Large group convened. Each small group will discuss results. Crossings that need an APS will be identified. Presenters will point out any relevant issues not covered.

Module 4

APS Features: Description of Current Technology, Guidelines and Usage

Some pages or sections in this module are from *Draft, Accessible Pedestrian Signals: Synthesis and Guide to Best Practice* (January 4, 2002) by Barlow, Bentzen and Tabor, prepared as part of NCHRP 3-62. Used with permission.

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Objectives – Module 4 – APS Features: Description of Current Technology and Strategies for Selection

Lecture discussion

(30 minutes)

The participant will gain an awareness of:

- Current APS technology in the U.S.
- Accessible pedestrian signals and their features including:
  - Types of information APS provide
  - Types of APS
  - APS features
  - Use of different features
  - Discussion of what MUTCD, or ADA Title II Draft PROW Guidelines require vs. what features are optional

Demonstration of APS units

(30 minutes)

Hands-on experience with demonstration units from various manufacturers.

This is referred to as Experiential Exercise in a later Table.

Lecture Discussion

(10 minutes)

Further discussion regarding APS technology and street crossing strategies at an intersection where APS are installed.

Introduction

Accessible Pedestrian Signals have been installed at various locations all over the world. Many installations have proven to be effective in their use and continue to be accessible on a daily basis.

The key to proper installation is a combination of successful retrofitting when incorporating an APS into existing hardware and an APS device that fits the characteristics of the pedestrian's needs and environment.

When an APS device is improperly installed and/or improperly chosen for that intersection the accessibility of that intersection remains in question.

Video of APS Installations in Morristown, NJ

South Street intersecting Elm and Madison Streets	Pushbutton integrated APS with speech and vibrotactile walk message, pushbutton locator tone, pushbutton message, tactile arrow, and long button press. Also location with cuckoo and with vibrotactile only APS: • Polara
South Street intersecting James Street	Overhead Pedhead mounted APS with cuckoo/chirp walk messages and pushbutton locator tone, and vibrotactile arrow: • Novax
Madison Ave intersecting Morristown Memorial Hospital Entrance	Pushbutton integrated APS with tone walk message and vibrotactile arrow: • Panich
Madison Avenue intersecting Franklin St and Turtle Road	Receiver-based system from: • Talking signs

Types of Information an APS May Provide

Information

In context of crossings viewed in videos, discuss the types of information an APS may provide

- the same information given to the sighted pedestrian about the status of the WALK/DON'T WALK signal;
- information about existence of and location of the pushbutton;
- notification about the beginning of the WALK interval through
  - audible indication
  - vibrotactile indication;
- location of the destination curb;
- intersection geometry through the use of maps, diagrams or speech;
- intersection street names in Braille, raised print, or speech; and
- Specific crosswalk identification through
  - tactile arrow
  - audible information.

Types of APS

Four Designs

A number of technologies exist which provide WALK and DON'T WALK information. All products produce a sound, vibration, or both, during the walk interval.

Pedhead mounted:

- Speakers mounted in, on or near the visible pedestrian signal head provide audible tones or speech messages

Pushbutton integrated:

- Audible tones, speech, and/or vibrating hardware integrated into the pedestrian pushbutton

Vibrotactile:

- Walk information only provided by vibrotactile indication at the pushbutton location

Receiver based:

- Infrared transmitters mounted in or on pedestrian signal heads that provide speech or vibrotactile messages at personal receivers, or LED pedestrian signal heads that pulse to transmit a code to call up a speech or vibrotactile message at personal receivers

Credit and future revisions

The contents of this section (from page 8 to 81) are directly from the *Draft, Accessible Pedestrian Signals: Synthesis and Guide to Best Practice* (January 4, 2002) by Barlow, Bentzen and Tabor, prepared as part of NCHRP 3-62. **At times parts of the text will reference chapters or figures, which are in the *Accessible Pedestrian Signals: Synthesis and Guide to Best Practice*. The synthesis in its final draft will be available to view soon at www.walkinginfo.org.**

Types of APS

Summary

A number of devices are available which provide WALK and DON'T WALK information. All products produce a sound, vibration, or both, during the walk interval.

- Currently available products are of four design types, plus various combinations, categorized by the location and type of WALK indication provided

Additional information

Additional information on APS features is provided in the following sections

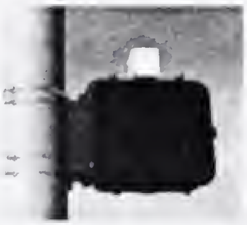
- Walk indications provides detailed information about walk indications
- Other APS features provides information on other APS features

Section contents

Information about the following APS types is included in this section:

- Pedhead mounted
- Pushbutton integrated
- Vibrotactile
- Receiver based

Pedhead Mounted

Prevalence	The type of APS that has been most commonly installed in the U.S. has a speaker mounted inside or in the vicinity of the pedhead.
Function 	Typical functioning of pedhead-mounted devices: • The APS emits a sound such as a bell, buzz, birdcall (typically a chirp or cuckoo), speech message, or some other tone during the walk interval of the signal only • Sound is *directly audible*, that is, it is heard by everyone in the vicinity; users do not require receivers to hear the sound • May include automatic volume adjustment
Walk indication	Sound, usually a cuckoo, chirp, or beep, is emitted during the WALK interval only.
Vibrotactile information	Not available, except as a separate component sold by one manufacturer.
Locator tone	Not typically available; some manufacturers sell the locator tone speakers as a separate component.

Pedhead Mounted

Installation

As typically installed in the US, they are attached to the pedestrian signal head and aimed toward the opposite curb:

- Intended to act as a beacon across the street
- Relatively loud as a consequence
- Sound from both ends of the crosswalk simultaneously

Pedhead speakers may be aimed in various directions; some cities in California have experimented with aiming the speaker down toward the waiting location and reducing the volume.

Fig 5-1. Example of pedhead mounted APS speaker *(left)*.

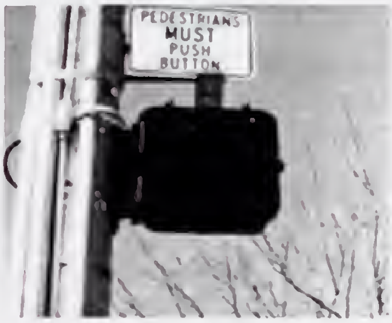
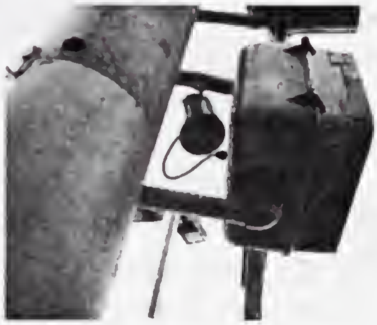


Fig. 5-2. Another example of Pedhead mounted speaker, aimed down toward pedestrian waiting area *(right)*.



Tone volume

A tone that is loud enough to be heard across the street:

- May be irritating to other persons in the vicinity
- May mask traffic sounds that provide critical safety information for blind pedestrians.
- Signals of the Pedhead mounted type, with tones currently used, have not proven to be localizable and do not provide directional information that many people hope for (Carroll, J. & Bentzen, B.L. 1999)

Tone volume and speaker alignment can be adjusted. Pedhead mounted APS do not have to be loud, US installations have typically assumed that beaconing is desirable and necessary.

Options

Additional options include:

- Audible beaconing
- Locator tone speaker or pushbutton with vibrotactile indications are available from one manufacturer of pedhead-mounted speakers

Pedhead Mounted

Limitations	Speakers must be carefully located so that they are above the end of the crosswalk they signal, or they provide ambiguous information about which crosswalk has the walk interval.
Recommendations	Devices should be responsive to ambient sound (automatic volume adjustment feature); some devices sold in the US are not. Draft Guidelines for Accessible Public Rights-of-Way require locator tones at pushbuttons.

Pushbutton Integrated

Prevalence

Common in Europe and Australia, now available in US; many recent installations are of this type.

Function

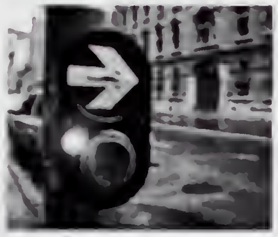


FIG. . PHOTO OF PUSHBUTTON INTEGRATED APS, WITH LARGE TACTILE ARROW

Pushbutton integrated APS systems have a speaker integrated into the pushbutton housing:

- Sound comes from the pedestrian pushbutton housing, rather than a speaker mounted at the pedhead
- Provide a locator tone, a WALK interval tone or speech message, and a raised arrow, which should be oriented parallel to direction of travel on the crosswalk
- Sound is *directly audible*, that is, it is heard by everyone in the vicinity; users do not require receivers to hear the sound
- Include automatic volume adjustment

Walk indication

The WALK indication may be a different tone, a rapid repetition of the locator tone, or a speech message.

Vibrotactile information

Vibrotactile information:

- Is typically provided in this type of signal by a button or arrow that vibrates to indicate the WALK signal
- Is useful for confirmation of which signal is sounding at a particularly noisy intersection
- Makes WALK signal information accessible to persons who have hearing loss in addition to visual impairment.

Pushbutton Integrated

Locator tone

The locator tone is a quiet, repeating tone that:

- Notifies pedestrians with visual impairments that it is necessary to push a button to actuate a pedestrian phase
- Aids in location of the pushbutton
- Aids in homing in on the opposite corner when crossing the street

Tones used in the U.S. vary, however the repetition rate is standardized at once per second. The duration of the tone is 0.15 sec. maximum, so that it is not mistakable for a vehicle back-up tone that usually sounds during approximately half of its cycle length.

Installation

When pushbutton-integrated APS are consistently mounted on poles at the ends of crosswalks, and near the crosswalk line furthest from the center of the intersection, they provide unambiguous information about which crosswalk has the WALK interval.

Pushbutton-integrated APS must be oriented on poles very precisely so the arrow is aligned in the same direction as the crosswalk whose signal is actuated by that pushbutton.

Tone volume

These signals, in their typical mode of operation and installation, are intended to be loud enough to be heard only at the beginning of the crosswalk, although the locator tone on the opposite curb becomes audible as the pedestrian approaches it.

Options

Additional options include:

- Verbal pushbutton message with street name, geometry, and signalization information
- Braille labels
- Tactile map of the crosswalk
- 'Alert tone' at the onset of the WALK interval
- Actuation tone and light
- Audible beaconing

Pushbutton Integrated

Limitations

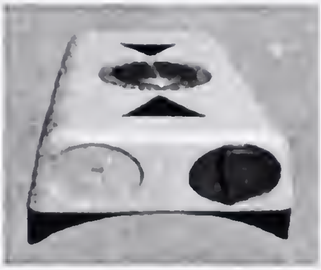
Potential limitations include:

- Extra wiring needed in order to install to the pushbutton
- Poles on which to locate the device should be close to the crosswalk location lines extended and the curb (or curb ramp)

Recommendations

Draft Guidelines for Accessible Public Rights-of-Way require audible and vibrotactile indication of the walk interval

Vibrotactile Only

Prevalence	Installed in some locations in the US in response to concerns about noise and misleading information.
Function	This type of APS provides only vibration at the pedestrian pushbutton. The arrow or button vibrates when the WALK signal is on.
Walk indication	Vibration of an arrow or pushbutton on the device.
Locator tone	No sound is generated with this device.
Installation	This device replaces the typical pushbutton. Vibrotactile devices must be oriented on poles very precisely so the arrow is aligned in the direction of travel on the crosswalk whose signal is actuated by that pushbutton. The device must be installed close to the crossing departure location in order for blind or deaf-blind pedestrians to stand with a hand on the device while aligned and ready to begin crossing.  FIG. 5-4. BOTTOM VIEW OF A VIBROTACTILE APS SHOWING THE RAISED ARROW WHICH VIBRATES AND IS ALIGNED WITH THE DIRECTION OF TRAVEL ON THE CROSSWALK.

Vibrotactile Only

Limitations

Problems and limitations to this type of device:

- Information about the WALK interval is only available to pedestrians who are familiar with the intersection and the signal.
- The pushbutton must be installed very precisely next to the crosswalk where users who need the vibrotactile information can stand, prepared to cross, with a hand on the vibrating surface
- For the APS to be of value, the person who is blind or visually impaired must know the APS is there and know where to look for it for it
- In a crowded location, it may be difficult for the blind pedestrian to get to the pushbutton and to keep his/her hand on the device while waiting

Recommendations

Although there is some interest in signals of this type because they are silent and do not disturb others, the PROWAAC recommendations opposed signals that were only vibrotactile because they are not available to those who are unfamiliar with the intersection. (PROWAAC X02.5.2.2 B)

PROWAAC and the *Draft Guidelines for Accessible Public Rights-of-Way* require that all signals provide vibrotactile and audible information. Vibrotactile information is useful in combination with audible information, when the APS are well located, for confirmation at particularly noisy intersections and for persons who are hearing impaired.

Receiver Based Systems

Prevalence

Installed for street crossing use in a few experimental locations in the U.S.

Remote infrared audible signage (RIAS) system is being installed extensively in Japan.

Function

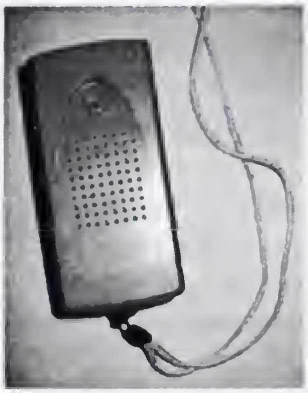


Fig. 5-5. Remote infrared audible sign receiver (Talking Signs®)

A receiver based system provides information to a receiver carried by the user. Users scan with receivers for pedestrian signal information as they approach the street and after they stop at the street edge. When receivers are oriented in the direction of pedestrian signals, a prerecorded message, which corresponds to the status of the signal, is received.

Two types of receiver based systems exist:

- Remote infrared audible signs (RIAS)
- Light emitting diode (LED)

Receiver-based systems:

- Provide clear unambiguous information and directional guidance at atypical intersections where there are more than four crosswalks, and when direct signals, such as tones, may overlap and therefore be unclear or misleading
- Information is only available to individuals who have the receivers; not audible to others

Walk indication

A speech walk message or vibration is provided to the handheld receiver to indicate the WALK interval.

Vibration message has not been standardized.

Walk indication is only received when standing within the limits of the crosswalk at the intersection.

- RIAS: users can pick up a repeating message stating the name of the street and the status of the cycle. For example:
  " Wait — Grove Street," or " Walk sign — Grove Street"
- LED signals: provide Walk or Wait message only

Receiver Based Systems

Vibrotactile information	Receiver-based systems can be adapted for vibrotactile use by deaf-blind pedestrians.
Locator tone	No locator tone.
Installation	For RIAS, transmitters are located in or on top of the pedhead housing. LED systems respond to a particular brand of LED pedhead, in which the specially equipped receiver detects the pulsing of the LED indication.
Tone volume	Located on the handheld receiver or headset, adjustable by user.
Options	Additional options RIAS can provide: • Orientation messages - As users approach an intersection, they pick up a message that includes the name of the street on which they are traveling, the direction of travel, the block they are on, and the name of the intersecting street they are approaching • Information about intersection signalization and geometry, and information about nearby landmarks such as public buildings and transit stops • Information for other tasks such as identifying bus stops, identifying public restrooms, identification and wayfinding in public buildings, wayfinding in transit stations, and real-time bus arrival information • May be engineered for output in other languages For LED systems, message content is limited to the pre-recorded messages or vibration signals set in the receiver. Receivers are dedicated to pedestrian signal information.

Receiver Based Systems

Limitations

These systems do not benefit other pedestrians. Such systems require users to obtain, carry, maintain and use receivers; this raises issues of distribution and maintenance, as well as concerns relating to availability to non-residents.

However, the increasing use of personal pagers, cellular telephones, and other mobile digital communications devices that could potentially receive transmitted pedestrian signal messages suggests that this may be an excellent means to provide pedestrian signal information in the future.

No locator tone.

Recommendations

PROWAAC does not recommend that travelers “be required to carry a single, function-specific receiver in order to access intersection information” (X02.5.2.3 discussion). The best use of a receiver based system at this time is to supplement APS having directly audible and vibrotactile information.

APS WALK Indications

Summary

The indication of the Walk interval is the most critical information provided by the APS. There are a number of APS available and different devices and WALK indications may be needed for different situations. This section provides information about the considerations in choosing walk indications, characteristics of different types of walk indications, and recommended usage that may assist in choosing the appropriate WALK indication. A discussion of walk indication volume, the use of audible beaconing, and suggested criteria for audible beaconing are included.

APS technology is changing rapidly and additional choices or features may become available. Those making purchasing decisions should consider the background information provided here which will be helpful in evaluating new technology.

Additional information

The other features of the device chosen can also affect the usability of the APS and the pedestrians' understanding of the WALK indication. Various features and their use are explained in detail in the next section.

Section contents

This section covers:

- Major considerations in determining the WALK indication
- Locations of WALK Indications
- WALK indication, provided by:
    - Tones
    - Speech messages
    - Vibrating surfaces
    - Messages to receiver hardware
- WALK indication volume
- Use of Audible beaconing

Walk indication

Criteria

APS indication of the WALK interval:

- Must be unambiguous with regard to which street has the Walk interval
- Must be audible from the beginning of the associated crosswalk
- Should be no louder than the associated quiet locator tone unless a louder beaconing feature is actuated for a single pedestrian phase
- Should have a much faster repetition rate than the locator tone, when tones are used to indicate the Walk interval

Above criteria are based on:

- MUTCD 4E.06
- Draft Public Rights-of-Way Accessibility Guidelines (draft PROWAG) 1106.2.3.1 Tones, 1106.2.3.2 Volume, 1106.3.2 Locator Tone, 1106.3.4 Optional Features
- PROWAAC X02.5.1.3(G) Separation, X02.5.2.2(A) Crosswalk Indication, X02.5.2.2(D) Walk Interval Tone, and X02.5.2.2(G) Volume

At this time there are a number of APS available that meet the above criteria. The following sections discuss these requirements further.

Major considerations

Four attributes

The WALK indicator should be:

- Readily detectable in the presence of ambient vehicular sound
- Highly localizable
- Uniquely recognizable as a WALK signal
- Unambiguous with regard to which crosswalk has the WALK interval

Readily Detectable

High detectability essential for usability:

- Pedestrians who are visually impaired must be able to hear the WALK indication clearly, over varying types and intensities of traffic sound
- While the signal needs to be detectable, it is desirable to have a sound that is not irritating to individuals in the area of the signal

Detection of WALK signals in ambient traffic sound:

- Vehicular sounds are concentrated in the lower frequencies
- The most detectable signals are those that are concentrated in frequencies different from those of traffic sound
- Factors that aid signal detection in ambient traffic sound
    - Multiple, sharp onsets
    - Large frequency component at about 880Hz

Less detectable signals:

- Both the commonly used cuckoo and chirp are less detectable than more rapidly repeating tones in 880Hz range, and speech messages
- Pedestrians with visual impairments who have age-related upper frequency hearing loss may have difficulty hearing signals having a fundamental frequency above 1kHz

Major considerations

Highly Localizable

High localizability helps users

- determine which signal is sounding;
- use the signal for alignment information (in locations with audible beaconing); and
- travel more directly toward the signal during their crossings.

Characteristics of highly localizable tones:

- Not pure tones
- Multiple harmonics or frequencies required—high and low
- Large frequency component at about 880Hz

Major considerations

Uniquely recognizable

Where the WALK interval is conveyed by tones, the tones should not be confusable with other tones in the street environment, such as vehicle backup warning beepers.

The most common tones used currently are the bird sounds like cuckoo and chirp.

- The 'chirp' sound is similar to the sounds made by several birds in the U.S. and is also mimicked by mockingbirds.
- Pedestrians who are blind have crossed streets with actual bird chirps, or failed to cross with APS tones because they were perceived to be actual birds.
- The cuckoo indication has not been reported to have been confused with birds in the U.S.

Vehicle backup beepers are not tightly specified in the U.S. but typically have a repetition rate of once every 1 to 2 seconds, and the beep is typically about half the length of the repetition rate. For APS WALK indications that consist of tones (excluding the cuckoo and chirp), the repetition rate in the U.S. is typically 8 to10 repetitions per second. The cuckoo and the chirp have a typical repetition rate of once every 1 to 2 seconds with a very short duration of the tones.

Speech messages for the WALK interval must be recognizable as a WALK message and not confused with pushbutton messages or other voices at an intersection. This can partially be accomplished by use of standardized wording for speech messages. In addition, the speech message must be understandable.

Major considerations

Unambiguous information

It is critical that pedestrians recognize which street is being signaled and begin their crossings within the WALK interval. Unfortunately, the most common solution used in the US is ambiguous. Surveys of pedestrians who are blind and the authors' evaluation of typical overhead pedhead mounted signals has revealed that they frequently provide ambiguous information about the crosswalk being signaled.

When the APS sound for both streets comes from the same general location, it is difficult to discriminate which street the tone or speech message applies to. The pedestrian who is blind waits to cross while standing approximately at the curb line, and may be 10 to 15 feet or more from the device speaker. The mounting of speakers does not provide clear indications of which street is being signaled, unless the speakers are mounted on two separate poles, at least 10' apart, and aligned with the crosswalk they signal.

The use of different tones for each direction requires pedestrians to know their direction of travel, and to know which tone is associated with which travel direction *in a particular jurisdiction.* (see discussion of tones on page 6-9) While in many situations, traffic movements also help clarify the signal status, beginning to cross with the wrong signal can be a fatal mistake.

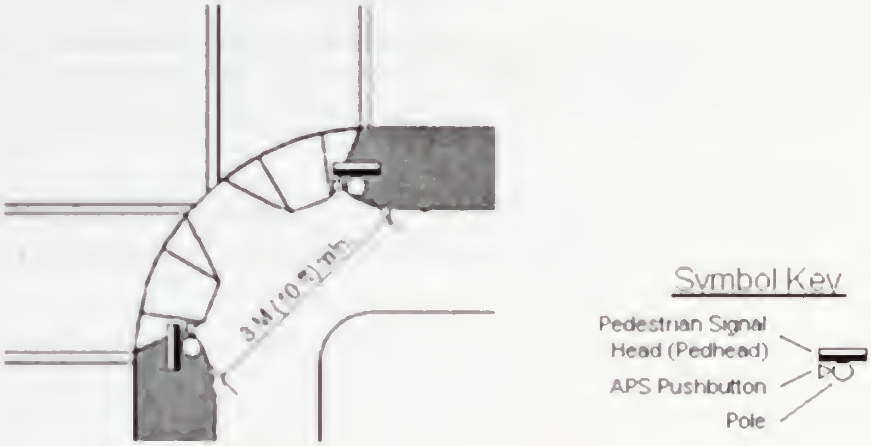
One factor that particularly affects ambiguity, location of the speakers for the WALK indication, is discussed in the next section:

Installation as well as device selection can affect the ambiguity of the information provided by the WALK indication. Chapter 9, Designing Installations, provides more information on deciding what features would be necessary or appropriate at a particular location.

Location of Walk Indications

Separation of sound sources

Ambiguity can be addressed by careful location of signal sounds. The best solution is location of the speakers precisely beside or above the end of associated crosswalks, and at least 3 m (10 ft) from another APS on the same corner, so it is clear from the source of the sound which crosswalk is being signaled.



Speech messages, if sound sources cannot be separated

If the APS must be located with two pushbuttons on the same pole or in locations that are not separated by at least 3m (10 ft), one alternative recommended by PROWAAC is that APS have speech messages. To provide unambiguous information such APS require:

- A tactile arrow aligned with the associated crosswalk
- A pushbutton message available during the flashing and steady don't walk, that identifies the intersection and the crosswalk associated with that pushbutton
- A WALK message that includes the name of the street being signaled at the onset of the WALK interval (otherwise the speech message is not useful to those unfamiliar with the area)

Location of Walk Indications

Possible additional solutions

Further developments in technology which may provide clarification of which crosswalk is being signaled, may include

- alternating the WALK signal from one end of the crosswalk to the other;
- having the WALK signal come from the far end of the crosswalk only; and
- developments in handheld receivers.

Methods of providing WALK indications

WALK indication is critical

The WALK indication provides critical safety information

It can be provided by use of

- tones;
- speech messages;
- vibrating surfaces; or
- messages to receiver hardware.

Each of these methods has advantages and disadvantages that relate to particular intersection geometry and signalization, signal volumes, pushbutton and speaker location and other factors.

Methods can be combined, for example, use of tones and a vibrating surface to indicate the WALK phase.

Tones

Description

The WALK indication of many APS is provided by an audible signal such as a beep, buzz, percussive sound, or cuckoo/chirp.

Basic issues

Tones consisting of multiple frequencies, high and low, with a large component at 880 Hz have been found to be highly detectable and localizable in the presence of traffic sound. Frequencies above 1kHz are difficult for persons with age related upper-frequency hearing loss to detect. However for persons with normal hearing, the presence of multiple higher harmonics aids localization.

Consistency in use of a particular tone for a WALK signal is greatly to be desired, however, there is insufficient research to support technical specifications for a particular tone at this time.

Issues, included in this section, that should be considered in the use of audible tones for the WALK indication are:

- MUTCD guidance on choosing audible tones
- Associating tones with direction of travel
- Use of additional tones
- Use of a single tone for crossing in all directions
- Other issues

Tones

MUTCD on WALK tones

MUTCD 2000 (4E.06) says that WALK tones should not be confusable with other sounds in the environment, including

- wind;
- rain;
- vehicle back-up warnings; and
- birds.

The WALK indication should also be different from a pushbutton locator tone; the pushbutton locator tone is defined by both repetition rate and duration of the sound (see Pushbutton Locator tone, page 46).

MUTCD guidance in 4E.06 also recommends that care should be exercised at locations where it may be difficult to determine which APS is sounding or where an unsignalized lane may be mistaken for a signalized one due to a loud beaconing APS. Some of the issues mentioned in the MUTCD guidance regarding tones can be more successfully addressed by careful installation and volume adjustment, rather than by choosing different tones.

More discussion of this issue is in the following sections.

Tones

Associating tones with direction of travel

Some audible pedestrian signals utilize two different tones that are associated with two different crossing directions. The most common tones used are the bird sounds like "cuckoo" and "chirp." The repeating cuckoo sound is normally used for north/south crosswalks, and the repeating chirp is normally used for east/west crosswalks. This has been the recommended signal in California and Canada.

The use of two tones for crossings in two different directions has been assumed to provide unambiguous information about which crosswalk has the WALK signal. However, research since 1988 has documented that such a system is often ambiguous.

- For two different sounds to be useful, users must remember which sound goes with which direction, and know their direction of travel. At intersections that are not aligned according to the primary compass coordinates, installers may be inconsistent in how signals are installed and information from paired audible tones may be ambiguous, except to frequent users of those intersections.
- In areas where the street system is curvilinear or otherwise irregular, it may not be apparent to a pedestrian who is blind that a heading has changed.
- Pedestrians may not know the compass orientation of a route of travel.

Several surveys (San Diego Association of Governments, 1988, American Council of the Blind, 1998, ITE Journal, 2000) have documented that blind pedestrians are often unsure which crosswalk is being signaled by a cuckoo or a chirp. MUTCD 4E.06 points out that the provision of different sounds for non-concurrent pedestrian phases has been found to provide ambiguous information, and PROWAAC (X02.5.2.2 (A)) would not permit the use of two different tones as the sole indication of which crosswalk has the WALK interval.

If two tones are used, the best way to make them unambiguous is to install them so the source of each WALK tone is localized in the area of the pedestrian waiting to cross the associated crosswalk, and speakers on a corner are separated by a minimum of 10 feet. (MUTCD 4E.08)

Tones

Use of additional tones

Some APS products have the capability of producing more than two different tones to accommodate intersections having more than two intersecting streets. But

- it is difficult to interpret the use of additional tones without specific instruction; and
- unfamiliar or non-standard tones are not useful to pedestrians who are not familiar with a given intersection.

Use of a single tone for crossings in all directions

In Europe and Australia, tones are used successfully to indicate the walk interval from pushbutton integrated APS. There is some variability in the tones used. Typically, the tone for WALK is the same tone as the locator tone, repeated at a faster repetition rate, usually 5 to 10 times faster. The same tone is used for all crossing directions.

The standardized location of the pushbutton in relation to the crosswalk makes it obvious to users which crosswalk has the walk interval. In all locations, pedestrians are beside the appropriate APS when they are waiting to cross, normally within arm's reach of the APS, and at some distance from the APS for another crosswalk.

Other issues

Other issues besides specific tone may increase the value for directional alignment and beaconing more than the tone, per se. For example, the presence of a quiet locator tone on the opposite curb during the clearance interval may make more difference in the ability of users to home in on the destination corner, than the choice of a particular WALK tone that normally ceases to sound when the pedestrian is only part way across the crosswalk.

Speech messages

Description

A speech message is provided during the walk interval, usually from a speaker located at the pushbutton, which states something like: ‘Maple Street, Walk sign in on to cross Maple.’

Basic issues

Some systems have the capability of utilizing directly audible speech messages to provide information about the status of the signal cycle. As for other WALK indications, the speech WALK message must be detectable, localizable, and recognizable.

For use as a WALK indication, a speech message must also be correctly understood by all users.

The following sections discuss some issues and problems to be considered in the use of directly audible speech messages:

- Associating speech messages with street to be crossed
- Need to know street name
- Cognitive complexity
- Which street should be named
- Understanding speech in noise
- Conveying necessary information
- Using recommended messages
- Recording messages
- Maintaining signals with speech messages

MUTCD on speech messages

MUTCD provides minimal information regarding speech walk messages. It states that: ”The verbal message that is provided at regular intervals throughout the timing of the walk interval shall be the term "walk sign," which may be followed by the name of the street to be crossed.” (MUTCD 4E.06)

Speech messages

Associating speech messages with street to be crossed

Speech messages from pushbutton integrated APS seem very user-friendly and have become popular in the US market. Such messages can communicate to all pedestrians which street has the walk interval.

However, the words and their meaning must be correctly understood by all users in the context of the street environment where they are used. Use of speech messages will not automatically solve all ambiguity problems that were discussed earlier in this chapter.

Draft Public Rights of Way Accessibility Guidelines allow the WALK indication to be provided by 'voice' but do not provide additional specifications. PROWAAC recommended the use of a speech WALK message to clarify to which crosswalk the signal applies, if signals for two directions cannot be separated by more than 10 feet. (X02.5.1.3G)

Need to know street name

Pedestrians have to know the names of streets they are crossing in order for speech WALK messages to be unambiguous. In getting directions to travel to a new location, travelers do not always get the name of each street to be crossed. They may only know that they have to cross four streets before looking for their destination. Therefore, the APS has to give the user the name of the street controlled by the pushbutton.

This can be done by means of a pushbutton information message during the flashing or steady don't walk intervals. See 7-7 for description of pushbutton information messages.

Speech messages

Cognitive complexity

Most APS that can provide speech WALK messages, can also provide a pushbutton message (see section on pushbutton message for more description) that clarifies which street the pushbutton and signal controls. In addition, they may have the option of Braille labels..

The user must combine the information from the pushbutton message or Braille label, the tactile arrow, and the speech WALK message, in order to correctly respond to the WALK messages, particularly if there are two pushbuttons on a pole. All may be necessary to correctly identify the street and crossing time at an unfamiliar intersection.

This complex process is much more cognitively demanding and liable to result in errors than the simple system adopted decades ago in Australia and several European countries, in which the source of a WALK tone is in the immediate vicinity of where pedestrians are standing to initiate the crossing associated with that tone.

Which street should be named?

A survey of travelers who are visually impaired, orientation and mobility specialists, and transportation engineers (Report on Speech Messages, Bentzen, et al., 2002) noted a difference in 'naming' of streets in speech messages. A message stating "Howard Street, WALK sign" was generally understood by engineers to indicate that the WALK sign was on for traffic traveling alongside Howard Street, while pedestrians who were blind or visually impaired and orientation and mobility specialists consistently interpreted it to mean that the WALK sign was on to cross Howard Street. WALK messages must contain the name of the street being crossed, or they may lead to misinterpretation by pedestrians who are blind or visually impaired.

Recommended messages are included in the section on Model messages on page 37.

Speech messages

Understanding speech in noise

Most APS currently available deliver the message from a speaker located at the pushbutton. Locating the APS speaker as close as possible to the crossing location is desirable.

Most pedestrians with visual impairments also have some degree of age-related upper-frequency hearing loss, limiting their understanding of speech in traffic conditions.

It will not be possible to make speech messages from APS loud enough to be intelligible in all ambient traffic conditions by most people unless they are also loud enough to potentially cause hearing loss in people in the immediate vicinity of the loud speakers.

In even moderate traffic conditions people who have age-related or other hearing losses, people who are not native English speakers, and people with cognitive disabilities are likely to miss hearing or to misunderstand some words, possibly resulting in misunderstanding entire messages.

In locations where speech messages have been broadcast from a pedhead mounted speaker, there has been difficulty making the speech information intelligible in the presence of traffic sounds. Increasing the volume of a speech message so it can function as an audible beacon is likely to result in decreased intelligibility of the speech message.

Speech messages

Conveying necessary information

Speech messages need to provide accurate information in a clear, concise, and standardized manner, so pedestrians will know what to expect from the messages and be more likely to understand them.

- Messages should *not* be worded in a way that seems to provide a 'command' to the pedestrian. For example, 'Cross Howard Street now' would not be an appropriate message.
- Messages should *not* tell users that it is "Safe to cross." It is always the pedestrian's responsibility to check actual traffic conditions.
- The term 'WALK sign' has been established as the most appropriate message to inform the pedestrian of the WALK indication. MUTCD states that: Standard: When verbal messages are used to communicate the pedestrian interval, they shall provide a clear message that the walk interval is in effect, as well as to which crossing it applies. The verbal message that is provided at regular intervals throughout the timing of the walk interval shall be the term "walk sign," which may be followed by the name of the street to be crossed.

Model speech messages are provided in the next section.

Model messages

Speech messages for the walk interval of directly audible APS should follow these model messages (Bentzen, Barlow and Franck, 2002).

- Model message for the walk interval, applicable to most intersections: **"Howard. WALK sign is on to cross Howard."**
- Model WALK message for intersections having an exclusive pedestrian phase: **"WALK sign is on for all crossings."**

Messages for actual installations should be developed on the basis of these models. Word order should not be changed. Where complete sentences are used in the models, they should be used in actual messages for the same situations. In the model messages, such words as street, avenue and road are not used. In some locations they may be needed to avoid ambiguity.

Speech messages

Recording messages

To be understood, speech messages must be carefully recorded, in a clear voice, with excellent diction, and moderate pacing.

There is no clear preference between use of a male or female voice. For persons with unimpaired hearing, a female voice will be understood somewhat better than a male voice because the frequency spectrum of the male voice is closer to that of traffic. For the large number of people who are visually impaired who also have age-related or other upper-frequency hearing loss, a female voice may not be as easy to understand as a male voice.

Maintaining signals with speech messages

Replacement of signals having speech messages necessitates custom recording rather than off-the-shelf substitution of components.

The speech message, as well as the associated pushbutton message or Braille label, is intersection and crossing specific. Manufacturers of APS with speech messages can provide replacement message 'cards' or provide software for the installer to record the speech messages. Care must be taken in the installation and/or replacement of signals to assure that the street name in any WALK message is the name of the street being crossed.

Vibrating Surfaces

Description

The push button, a second button on the push button housing, or a raised arrow on the housing vibrates during the walk interval.

Indication of the walk interval with a vibrating surface is commonly provided on pushbutton integrated signals, in addition to the audible indication.

Basic issues

The vibration may be:

- synchronous with the pulsing of the audible signal (slow during DON’T WALK, and faster during WALK); and
- present only during the walk interval.

The vibrating surface:

- lets pedestrians who are deaf-blind know when the walk interval is in effect;
- can help all pedestrians confirm that the pushbutton they have actuated is the one that now has the walk interval; and
- may provide confirmation of the walk interval at a particularly noisy intersection.

Vibrotactile signals:

- Are useful only when the vibrating surface is close enough to the curb ramp, near the curb line, so pedestrians who are blind can be aligned and prepared for crossing while still keeping their hand on the signal
- May be difficult for pedestrians who are blind to locate, or to wait with their hand on the pushbutton
- If they are vibratory only, are useful only to persons who know they exist and know where to find them

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Recommended use

Although signals that only provide vibratory information only have been installed in some locations, PROWAAC recommended that vibrotactile indications should be used only in combination with audible messages, either tones or speech messages.

Draft Public Rights of Way Accessibility Guidelines require all devices in newly signalized installations or alterations where there are pedestrian signals, to have audible and vibrotactile indications of the walk interval.

Messages to receiver hardware

Definition

WALK indications of receiver-based systems can be provided by speech messages or by vibration of the handheld receiver. The pedestrian who is blind must have a receiver and point it at the pedhead to receive the verbal or vibratory message.

Basic issues

WALK indications of receiver-based systems can be provided by speech messages or by vibration of the handheld receiver. There are currently two technologies that provide speech messages to personal receivers.

- Remote infrared audible signage (RIAS) is a system in which unique messages that are recorded in a transmitter are transmitted by infrared light to receivers.
- LED pedestrian signals provide a system that can be pulsed to call up a limited selection of speech messages that are recorded in receivers.

If used, the speech messages must contain the words ‘WALK Sign” and may also contain the name of the street to be crossed. (MUTCD 4E.06)

Precise installation

When the pedhead mounted transmitters in RIAS systems, and LED pedestrian signal heads are installed and maintained precisely in line with the associated crosswalk, they are both capable of providing very precise directional information to users without adding to noise pollution. If installed so that they are not within the crosswalk, or are not aimed directly across the crosswalk, the installation can lead to ambiguity about which crosswalk has the walk interval, and to incorrect information about the location of the opposite corner.

Best use

PROWAAC recommended that the best use of receiver-based systems is to supplement APS having directly audible information, as receiver-dependent systems are accessible only to those persons who own, maintain and are currently using the appropriate receiver.

Draft Public Rights-of-Way Accessibility Guidelines require audible and vibrotactile indications of the Walk interval provided by a signal device located at the intersection.

Volume of WALK indication

Problems with loud audible signals

Loud overhead audible signals have been problematic to neighbors of APS installations.

In addition, the sound of the signal may prevent pedestrians who are visually impaired from

- hearing critical traffic sounds used for alignment ;
- determining that cars have stopped;
- hearing cars that may be turning across their path; and
- localizing on the signal source

Guidance on loudness

The WALK indication should normally be audible only from the beginning of the crosswalk, not across the intersection. (MUTCD 4E.06, PROWAG 1106.2.3.2, PROWAAC X02.5.2.2.(G)) Draft guidelines require the walk indication to be 5dB maximum above ambient sounds when measured 36 inches from the device.

PROWAAC recommended an exception for intersections where audible beaconing is needed, when the audible beaconing is activated. (See the following section on audible beaconing for further explanation). Draft Public Rights-of-Way Accessibility Guidelines do not address this issue.

The guidance on loudness reflects a change from the expectations regarding setting the volume typical of previous installation of APS in the U.S.

Sound volume levels

The pushbutton locator tone and WALK indication are to be between 2dB to 5 dB above ambient noise levels and should respond to ambient sound; the MUTCD specifies a maximum volume of 89dB. The system is to be adjusted so the sound is audible no more than 6 to 12 feet from the sound source, or at the building line, whichever is less.

Volume should be individually adjusted at each APS installation for satisfactory performance.

Audible beaconing

Description

Use of an audible signal in such a way that blind pedestrians can home in on the signal from the opposite corner as they cross the street.

PROWAAC defined audible beacon as: “a permanently fixed source emitting sound for directional orientation.”

Basic issues and information

A minority of crosswalks require audible beaconing, in which the sound source provides directional orientation. Where audible beaconing is required, the WALK signal is normally louder than any associated locator tone.

MUTCD and PROWAAC recommendations are that the beaconing be called up by special actuation, rather than the APS functioning in the louder mode all the time. The recommended form of special actuation is an extended button press (holding the pushbutton in for a longer period of time).

On-going research may refine these recommendations.

Ways to provide beaconing

Beaconing can be provided in several ways, any of which are initiated for a single cycle by an extended button press. (MUTCD 4E.08 and PROWAAC 2.5.1.2F & 2.5.2.3A,B).

- The volume of the WALK tone and the subsequent locator tone for one signal cycle may be increased
- The audible WALK signal may be alternated back and forth from one end of the crosswalk to the other, or
- The signal may come from the far end of the crosswalk only

Installing audible beacons

Audible beacons speakers must be oriented in line with the relevant crosswalk.

- If the speaker is not carefully oriented, the signal may give ambiguous information about which street has the WALK interval, and ambiguous information for traveling straight across the street.
- Beaconing is enhanced by the presence of a locator tone that users can home in on as they approach the destination corner, island or median having an accessible pushbutton.

Audible beaconing

Criteria for use of audible beaconing

Not all crosswalks at an intersection may need beaconing; beaconing may actually cause confusion if used at all crosswalks at some intersections.

Audible beaconing may be needed at:

- Intersections having skewed crosswalks or irregular geometry such as multiple legs.
- Crosswalks longer than 70 feet, unless they are divided by a median that has another APS with a locator tone
- Crosswalks where APS are requested by individuals with severe veering problems.

Beaconing on demand

PROWAAC recommends that beaconing be available on demand rather than as a constant feature of the device. This will address noise pollution concerns, etc.

Locations where beaconing is not appropriate

Audible beaconing is not appropriate at locations with free right turns or split phasing, due to possibility of confusions. See discussion on page 10-3. Other methods of providing directional guidance, such as tactile guide strips, should be considered at those types of locations.

Other APS Features

Summary

This section describes APS features other than the WALK indication. It is a review of features currently available. The technology of APS is changing rapidly and additional items may become available. Those making decisions about purchases and features to be included should consider the background information provided here. Understanding current features may be helpful in evaluating new technology.

The module on installation provides more information on deciding what features would be appropriate at a particular location.

Section contents

The following APS features are discussed in this chapter:

- Pushbutton locator tone
- Tactile arrow
- Pushbutton Information message
- Automatic volume adjustment
- Alert tone
- Actuation indicator
- Tactile map
- Braille and raised print information
- Extended button press
- Passive pedestrian detection
- Remote activation
- Clearance interval tones

Pushbutton Locator Tone

Description

A pushbutton locator tone is "A repeating sound that informs approaching pedestrians that they are required to push a button to actuate pedestrian timing and that enables pedestrians who have visual disabilities to locate the pushbutton." (MUTCD 2000; 4E.08)

The pushbutton locator tone is referred to by different names in manufacturer's brochures. These include:

- Pole locator
- Locator signal
- Locator tone
- Locating tone
- Locator audible

Additional information

Pushbutton locator tones typically sound during the flashing and steady DON'T WALK intervals. A slowly repeating tone or ticking sound is adjusted to be heard no more than 6 to 12 feet (2 to 4 meters) from the push button or to the building line, whichever is less. The locator tone informs pedestrians of the need to push a button, and provides an audible cue to the location of the pushbutton, as well as the destination corner.

In available products, the pushbutton locator tone varies from a click sound to a beep type tone. However, some aspects are standardized by language in the MUTCD 2000. The tone shall repeat at 1 second intervals and shall have a duration of 0.15 seconds or less.

The pushbutton locator tone typically has automatic volume control. A microphone or sensing device is installed in the APS device or in the pedhead to monitor intersection sound levels and adjust the volume of the locator tone, as well as the WALK indication volume. The locator tone is to be adjusted to between 2dB and 5dB above ambient sound levels, measured 36 inches from the pushbutton.

The web page at www.walkinginfo.org includes a sample locator tone.

Pushbutton Locator Tone

Reference

MUTCD 4E.08

Draft Public Rights-of-Way Accessibility Guidelines 1106.3.2 Locator tone

PROWAAC X02.5.1.2D and X02.5.1.5

How used

Pedestrians who are blind who are unfamiliar with an intersection will approach the intersection:

- Upon hearing the locator tone, or two locator tones if there are two pushbuttons, will realize that the signal is actuated
- Will probably continue to the curb or curb ramp location, determine their location and alignment, and listen to traffic to become familiar with the intersection layout and sounds
- If the pushbutton is not in reach, they will return to the pushbutton locator tone that they believe to be the pushbutton for their crossing
- After reaching the pushbutton and checking the arrow alignment to ascertain that the arrow is aligned parallel to the crosswalk they want to use, indicating that it is the correct pushbutton, they will push the button and return to realign to cross the intersection
- They may find it necessary to repeat the process if they don’t feel they’re realigned appropriately when the pedestrian phase begins
- As they cross the street, they will begin listening for the pushbutton locator tone for the APS on the opposite side of the street and may be able to home in on it as they reach the last lane of traffic

Tactile Arrow

Description

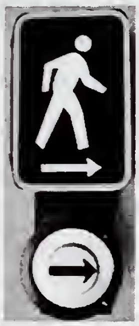


Figure xx: Photo of device with raised tactile arrow on the pushbutton.

Most APS devices that are integrated into the push button incorporate a raised (tactile) directional arrow that helps users know which crosswalk is actuated by the pushbutton. This provides confirmation that is similar to the printed sign and arrow commonly provided for pedestrians who are sighted.

The arrow may be part of the pushbutton, above the pushbutton or on top of the device. On some devices, this arrow also vibrates during the WALK interval.

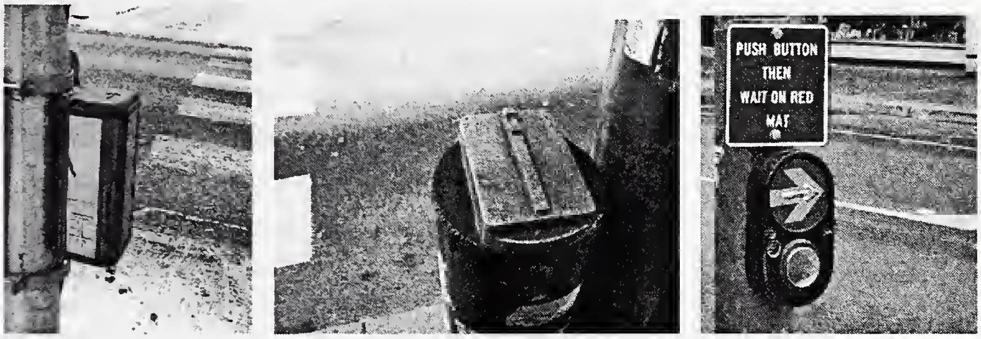


Figure xx: Three photos of different types of APS arrows aligned with the direction of travel on the crosswalk

Tactile Arrow

Additional information

The tactile arrow is of minimal assistance in aligning for a crossing, however it is important that the arrow point in the direction of travel on the crosswalk. Arrows on available devices are either on the face of the device or on top of the device (see photos)

The arrows that work best for alignment for persons who are blind are ones that have a relatively long shaft and are oriented so that they can be read with the hand held in a horizontal position.

For arrows on the face of the device, the alignment is determined by the installation of the pushbutton on the pole. Those on the top of the pushbutton integrated APS are typically glued into place after the pushbutton is installed and their alignment can be adjusted separately from the pushbutton.

To align the arrow properly, the installer needs to understand that pedestrians are expecting the arrow to be aligned with the direction of travel across the crosswalk to provide information about the crosswalk alignment. The purpose is not to point toward the beginning of the crosswalk, or the curb ramp location. Misalignment of the arrow by a few degrees can direct a blind pedestrian into the center of the intersection.

Reference

Pushbutton and arrow should be within 5 feet of the crosswalk lines extended, (MUTCD 4E.08), aligned in the direction of pedestrian travel controlled by the pushbutton. (MUTCD 4E.08; Draft Public Rights-of-Way Accessibility Guidelines 1106.4.1, PROWAAC X02.5.1.4 (A))

Arrows should have good visual contrast with their background so that all users, including those having low vision, will see them readily. (MUTCD 4E.08, Draft Public Rights-of-Way Accessibility Guidelines 1106.4.1)

Tactile Arrow

How used

Pedestrians who are blind will use the tactile arrow to determine and confirm which crosswalk the pushbutton controls and the general direction of travel on the crosswalk and will use other clues from traffic sounds to confirm their alignment and crossing direction.

They will typically proceed in as straight a line as possible from the device to the curb of the perpendicular street in the direction of the arrow, which means the APS should be as close as possible to the extension of the crosswalk lines.

Pushbutton Information Message

Description

A pushbutton information message is a speech message that provides additional information when the pedestrian pushbutton is pushed, and is a feature available on some pushbutton integrated APS. This message may provide the name of the street that the pushbutton controls, as well as other intersection geometry or signalization information.

This message is referred to by different names in the information from manufacturers. These include:

- Voice on location
- Informational message
- Verbal message
- Additional message
- Instructional/location message

Additional information

The pushbutton information message is provided from a speaker located at the pushbutton, during the flashing and steady DON'T WALK intervals only. The message is intended to be audible when standing at the pushbutton location. Pedestrians may be required to press the pushbutton for approximately three seconds (see extended button press) to call up this additional speech message.

The pushbutton message, in conjunction with the tactile arrow, can clarify the street names and the crosswalk controlled and signaled by the device. To do so, the pushbutton message must indicate which street is actuated by the pushbutton, and the arrow must point in the direction of travel of that crosswalk.

A message that includes only the intersection street names, without clarifying which street is actuated by the pushbutton, does not provide unambiguous information. See recommendations, below, for pushbutton message wording.

Some devices respond to the extended button press by providing all possible features so the extended button press may activate the audible beaconing feature as well as provide additional information.

Pushbutton Information Message

Limitations on use

An APS pushbutton should not be used for landmark information or to inform pedestrians with visual impairments about detours or temporary traffic control, according to recent research. (Bentzen et al. 2002)

When to use

PROWAAC X02.5.1.4 A recommends requiring that unambiguous information be provided at pushbuttons indicating which WALK signal is requested by that pushbutton. The MUTCD says that unambiguous information should be provided. (MUTCD 4E.08) PROWAAC (X02.5.1.4 C) also recommends requiring intersection identification information at each APS. Pushbutton messages are a good way to provide this information.

Pushbutton Information Message

Pushbutton message wording

Pushbutton information messages should be developed according to the following models (Bentzen et al 2002). The full report, *Determining Recommended Language for Speech Messages used by Accessible Pedestrian Signals*, is available on the Accessible Intersections page of the web site of the Institute of Transportation Engineers, www.ite.org:

- Model pushbutton message: **“Wait to cross Howard at Grand.”**
- Model pushbutton message for intersections having an exclusive pedestrian phase with right turns-on-red prohibited: **“Wait to cross Howard at Grand. Wait for red light for all vehicles.”**
- Model pushbutton message for intersections having an exclusive pedestrian phase with right turns-on-red permitted: **“Wait to cross Howard at Grand. Wait for red light for all vehicles. Right turn on red permitted.”**
- Model pushbutton message for angled crosswalks: **“Wait to cross Howard at Grand. Crosswalk angles right.”**
- Model pushbutton message for crosswalks to medians where a second button push is required: **“Wait to cross Howard at Grand. Short** WALK **phase. Raised [or cut-through] median with second pushbutton.”**
- Model pushbutton message for signalized crosswalks to splitter islands: **“Wait to cross right turn lane to island for Howard and Grand crosswalks.”**
- Model pushbutton message for crosswalks at “T” intersections: **“Wait to cross Howard at Grand.”** (Not different from standard intersection identification message.)

Use “Street,” “Avenue,” etc., where needed, to avoid ambiguity.

Keep the word order illustrated in the above model messages.

Where model messages have complete sentences, sentences should be complete, for best comprehension.

Pushbutton Information Message

How used

Pedestrians who are unfamiliar with the intersection, or who wish to confirm their location, will:

- Locate the pushbutton and depress the button for approximately three seconds
- The pushbutton message will play and pedestrians can stand beside the pushbutton speaker to listen to the speech message
- Pedestrians can push the button repeatedly, to hear the message as many times as necessary to understand it

At a location with two pushbuttons on a pole and a speech WALK message, it is particularly important that users understand and recognize the street name.

Automatic volume adjustment

Description

Many accessible pedestrian signals have volume control that is automatically responsive to ambient (background) sound.

- A louder signal is produced when vehicle and other noise at an intersection is high, as during rush hour or construction; a quieter sound is produced when traffic volume is lower, such as during night-time hours.
- The devices that respond to ambient sound include a microphone that continuously samples the noise levels and varies the volume in response to the existing sound levels.
- The microphone may be incorporated into the pushbutton housing, or may be located at the pedhead.

This feature also is referred to as:

- Automatic volume adjustment
- Automatic gain control (AGC)
- Ambient sound adjustment

Additional information

Some signals can also be pre-set for varying volume within particular ranges.

- Most signals with automatic volume control have a minimum limit placed at about 30 dB and a maximum limit at about 90 dB.
- A signal that is 2-5 dB above ambient sound, as perceived at the departure curb, is loud enough to inform pedestrians who are blind that the WALK interval has begun. If the microphone is installed at the pedhead, and the pedhead is set back from the curb, the volume as sensed by the microphone is not as loud as that perceived by pedestrians waiting at the curb. Therefore, at each installation, the setting must be adjusted depending on the location of the microphone in relation to pedestrians waiting to cross.
- Some APS allow the installer to set the range of the locator tone and the WALK indication separately; others are set the same.
- Some APS have adjustments for microphone sensitivity as well as volume.

Automatic volume adjustment

Reference	MUTCD 4E.06 Draft Public Rights-of-Way Accessibility Guidelines 1106.2.3.2, 1106.3.2, PROWAAC X02.5.2.2G
How used	Automatic volume adjustment provides flexibility and allows APS to be installed that are not disturbing to neighbors. The APS is only loud when traffic volumes and noise levels are high since the signal automatically adjusts to the sound in the environment. This is also helpful to blind or visually impaired pedestrians, as the APS does not drown out essential traffic sounds necessary for crossing.

Alert tone

Description	A very brief burst of high frequency sound, rapidly decaying to a 500 Hz WALK tone, is used by one manufacturer to alert pedestrians to the exact onset of the WALK interval.
Additional information	This may be particularly useful if the WALK is not easily audible in some traffic conditions. As used in Australia, the alert tone is 14dB above the ambient sound level. Australian engineers believe the alert tone encourages faster initiation of crossing, decreasing the likelihood of conflict between pedestrians and turning vehicles. When crossings are initiated faster, pedestrians also clear the intersection faster. Example of an alert tone is on the web page of www.walkinginfo.org
Reference	Not mentioned in Draft Public Rights-of-Way Accessibility Guidelines, MUTCD or PROWAAC.
How used	An alert tone may be particularly helpful in locations with high ambient noise levels to alert pedestrians to start of a speech WALK message, or of a WALK indication that is hard to hear over traffic sound.

Actuation indicator

Description

Either a light, a tone, a voice message, or both audible and visual indicators may indicate to pedestrians that the button press has been accepted.

Additional information

- Several APS devices emit an audible click or beep when the pushbutton is pushed. One provides a speech confirmation message.
- If there is a light, it is at or near the pushbutton and remains illuminated until the WALK indication is illuminated. A light is helpful to persons with low vision, but persons who are blind require a tone.
- In some devices, this indicator is triggered by the device itself, meaning "A pedestrian has pushed the button." In others, the indicator is triggered by the controller, meaning "The controller has received a request for a pedestrian timing."

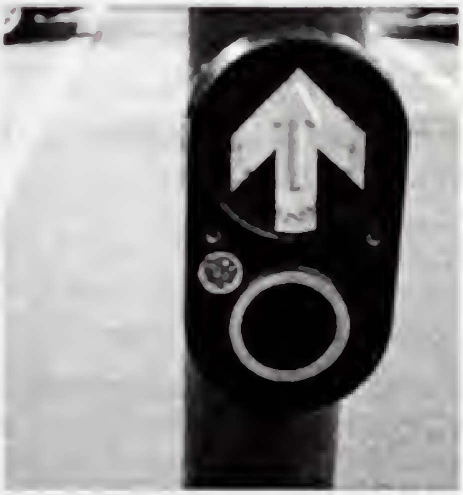


Fig x-x Photo of APS in Australia with the actuation indicator

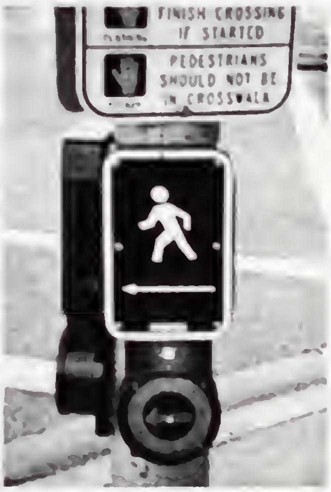


Fig x-x Photo of APS in US with Actuation indicator illuminated

Reference

MUTCD 4E.07 (pilot light)

PROWAAC X02.5.1.2 PROWAAC recommends an audible and visual indication that the button press has occurred.

How used

The indicator assures pedestrians that the device is working, thereby encouraging pedestrians to wait until the onset of the WALK interval.

Tactile map

Description

One manufacturer's push button-integrated signal can incorporate a raised schematic map showing what will be encountered as the pedestrian negotiates the crosswalk controlled by that push button.

Additional information

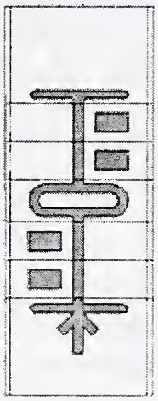


Figure xx. This tactile map shows (from the bottom) "START" that there are 2 vehicle lanes (traffic from the left) 1 median and then 2 vehicle lanes (traffic from the right) and then "END".

This map is made up of changeable 'slugs' inserted in the side of the pushbutton housing. It must be set up for each crosswalk of the intersection. The map information shows just the crosswalk controlled by that signal, not the entire intersection. It is read from the bottom to top showing lanes as pedestrians would reach them.

Map information typically includes

- the number of lanes to be crossed;
- whether these are vehicular or bicycle lanes or trolley tracks;
- which direction traffic will be coming from in each lane; and
- whether there is a median.

Symbols used are not standardized in the US, but one manufacturer has developed a standard set that is used in other countries.

Reference

Draft Public Rights-of-Way Accessibility Guidelines state that 'where provided, graphic indication of the crosswalk shall be tactile'. Also requires that the figures contrast with the background.

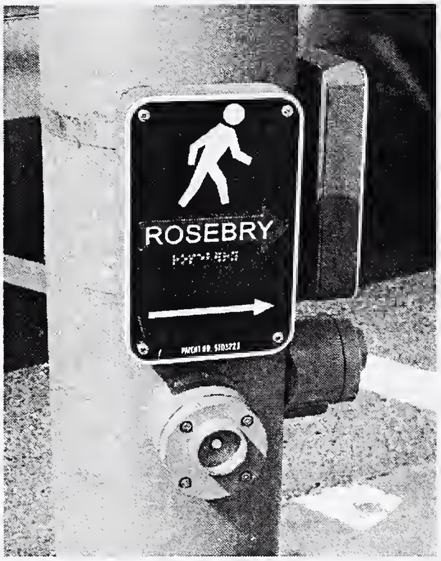
PROWAAC X02.5.1.4D recommends map indications that are similar to the Swedish symbols.

How used

- Pedestrians unfamiliar with the intersection or crossing would hear the locator tone and locate the pushbutton and map.
- Standing facing the crossing, they could 'read' the map and could learn how wide the street is, and what they will encounter in the crosswalk, before they begin to cross.
- They can also learn whether the pedestrian signal controlled by that pushbutton provides a crossing time for the entire crossing or just to a median or island. If the signal is just for a portion of the street, the map indication will end on a 'median' graphic, indicating that there is another crossing, either controlled or uncontrolled.

Braille and Raised Print Information

Description



Some manufacturers will provide the name of the associated street in Braille above the pushbutton, as an option.

FIG. X-X. BRAILLE STREET NAME IS LOCATED BELOW THE LARGE PRINT STREET NAME.

Additional information

Although this may be helpful to some pedestrians who are blind, many would not locate the Braille because of the lack of a standardized location for such information.

- Many individuals who are blind do not read Braille, however, those who do would prefer Braille information to confirm which street is controlled by the pushbutton.
- Some individuals who do not read Braille may be able to read large print, or raised print.
- The street name on a device should be the name of the street whose crosswalk is controlled by the pushbutton.

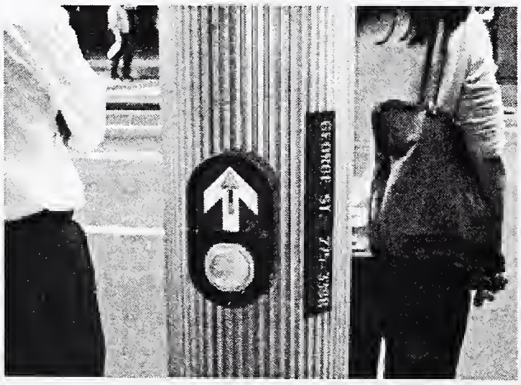


Figure XX: APS and raised print and Braille street label in Sydney Australia.

PROWAAC suggested that providing intersection identification information in an audible format may be useful to the greatest number of users.

Braille and Raised Print Information

Reference

Draft Public Rights-of-Way Accessibility Guidelines require street name information in raised characters on the face of the device or its housing or mounting.

MUTCD 4E.08 states: "Name of the street ...may also be provided in accessible format...."

PROWAAC X02.5.1.4C recommended that signs at APS include the street name in Braille and raised print.

How used

Braille information and/or raised print information, in combination with the tactile arrow

- can help pedestrians learn or confirm the street name which is controlled by the pushbutton; and
- can help pedestrians choose which of two pushbuttons to press to cross the desired street.

Extended button press

Description

Extended button press is an option on many APS that actuates additional accessibility features. Most require the pushbutton to be pressed for between one second and three seconds to activate the features. The length of time will be standardized as soon as on-going research indicates the optimal length.

Other names for this feature in manufacturers literature include:

- BAT – Button actuated timer
- Extended push
- Extended button press

Features called

Possible features called by the extended button press include:

- The accessible WALK indication
- Providing a pushbutton message identifying the intersection and the crosswalk, at the pushbutton, during the DON'T WALK or flashing DON'T WALK
- Providing a pushbutton message with intersection signalization and geometry information, at the pushbutton, during the DON'T WALK or flashing DON'T WALK
- Audible beaconing by increasing the volume of the WALK tone and the associated locator tone for one signal cycle, so a blind pedestrian might be able to use the sound from the opposite side of the street to provide directional guidance;
- Audible beaconing by alternating the audible WALK signal back and forth from one end of the crosswalk to the other;
- Audible beaconing by providing the WALK indication from the far side of the street at an elevated volume for one signal cycle
- Providing extended crossing time

Any or all of these features would be called by pressing and holding the same button that is used by all pedestrians.

Extended button press

Additional information

Some systems have used an additional pushbutton to actuate the accessible signal. APS should be actuated by the same button used by all pedestrians.

Pedestrians who are not aware of local practice may not be aware that a signal is APS equipped, and may not be able to call the accessible signal or take advantage of the additional features, because they may not press the button long enough. However, PROWAAC recommended that "Additional features which may be required to make a specific intersection accessible shall be brought up by a longer press of the push button." And "An additional button should not be used to bring up additional accessibility features. All accessible features available are to be actuated in the same way. Thus, for a given signal, an extended button press could request more than one additional feature."

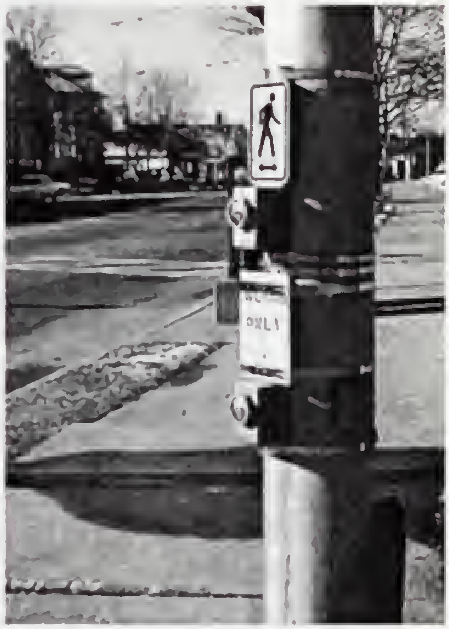


Fig. 7-x. Contrary to PROWAAC recommendations, the photo shows an additional button used to bring up additional accessible features. The lower sign reads "BLIND ONLY."

There is limited familiarity with these recommendations among individuals who are blind. Locations that use such a system should provide educational materials and information to individuals who are blind or visually impaired in the community to assure that they can take advantage of the features.

Reference

Draft Public Rights-of-Way Accessibility Guidelines 1106.3.4 Optional Features

PROWAAC X02.5.2.3

MUTCD 4E.08

Extended button press

How used

Use will depend on the feature(s) called by the extended button press. See the section on audible beaconing (in Walk indications), and pushbutton information message (in this section) for further discussion of the use of those features. The intent is to allow individuals who are blind to have some choice in the use of the accessible features.

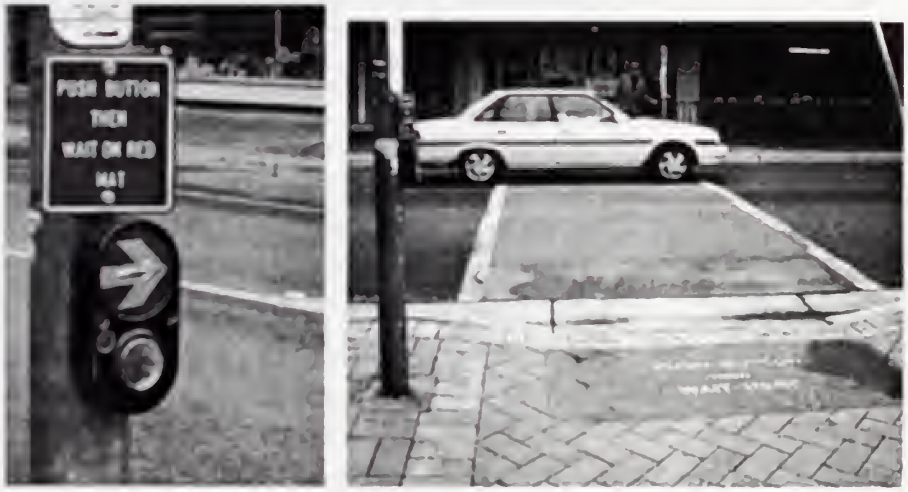
- As the extended button press feature is more commonly installed, it would be expected that pedestrians who are blind or visually impaired might hold the button longer at unfamiliar intersections in order to determine what features are installed and decide how they want to cross the street.
- The extended button press allows pedestrians to decide if they want all the possible accessible features at an intersection.
- Pedestrians may decide if they want audible beaconing at a location, which many may find necessary only at certain times and with certain traffic patterns.
- Individuals who are unfamiliar with an intersection can get intersection information but the message is not played every time the button is pressed, which some believe would be annoying.

Passive pedestrian detection

Description

Passive pedestrian detection is available to call the WALK indication and can extend the clearance interval. Authors are not aware of US installations that include audible signals as well as visual signals, but this technology is known to be in use in the United Kingdom, Australia, New Zealand and the Netherlands.

One pushbutton integrated APS provides the option of triggering the pushbutton locator tone through sensors (piezo-electric, infrared, or microwave) when the pedestrian enters the detection zone.



Caption: Midblock crossing in Australia with sensors in a specific area of the sidewalk and an APS.

Additional information

An example of the use of detection technology is the “Pedestrian User-Friendly Intelligent (PUFFIN) crossing in use in England since 1993 (Department of Transport, 1993). PUFFIN crossings employ pedestrian detectors for both the pedestrian waiting area and the crosswalk.

Waiting area detectors may be either pressure mats with piezo-electric sensors, infrared or microwave detectors mounted on the signal pole, or video cameras serving remote sensor software. After a pedestrian has pressed a push button to actuate the WALK interval, detectors confirm the presence of pedestrians standing near the crossing. If the pedestrian leaves before the onset of the WALK interval, the call for the pedestrian phase is canceled. Pedestrians who are visually impaired must be able to locate the push button, the waiting area, and the crosswalk if such detectors are to be effective.

Crosswalk detectors are microwave or infrared sensors that respond to pedestrians moving in the crosswalk. As long as a pedestrian is detected in the crosswalk, a preset extension is added to the pedestrian clearance interval, enabling later-starting or slower moving pedestrians to clear the intersection before vehicular traffic resumes.

In Adelaide, Australia, installation of passive pedestrian detection in the crosswalk, for extending crossing time, is now standard at intersections where there is a newly installed APS.

Reference

MUTCD 4E.08

Draft Public Rights-of-Way Accessibility Guidelines 1106.3.4 Optional Features

How used

While passive detection of pedestrians for activating the locator tone may be helpful in reducing noise near the intersections, pedestrians who are blind may not be approaching the crosswalk or intersection within the detection zone. They also may not know about it unless they are familiar with the intersection.

It does have the advantage of reducing driver waiting time if the pedestrian crosses in a gap in traffic instead of waiting for the pedestrian phase.

Remote Activation

Description	At least one manufacturer offers the option of a handheld pushbutton that sends a message to the APS to call the pedestrian phase. It operates on a limited range radio frequency (such as a garage door opener or car door unlock device) within 100 feet.
Additional information	Manufacturer's information does not clarify how the device would differentiate between locations at the intersection or if using the device would place a pedestrian call for all crossings of the intersection.
Reference	Not mentioned in MUTCD, Draft Public Rights-of-Way Accessibility Guidelines or PROWAAC
How used	Pedestrians could place a pedestrian call as they approach the intersection, without having to travel to the pushbutton location. This would make it unnecessary to deviate from the travel path and may be particularly an advantage for wheelchair users.

Clearance Interval tones

Description

A tone or other message sounds during the pedestrian clearance interval, at a different rate, tone, or with a different speech message, than the WALK interval indicator. This is not the same as the APS reverting to the locator tone during the flashing DON'T WALK and DON'T WALK interval.

Clearance interval information is sometimes provided by APS in Japan and in some parts of Canada.

- In Canada, it may be provided by a tone that repeats at a faster rate than the WALK signal. For example, if the WALK signal is a "cuckoo" at 1 time per second, during the clearance interval the "cuckoo" is sounded 2 times per second.
- In Japan, a variety of alternatives are available including a European emergency vehicle "ba-boo" sound, and various melodies.

Additional information

Advantages:

- Lets pedestrians who are visually impaired who have begun to cross the street know that the clearance interval prevails, that is, that they do not yet have to fear the onset of perpendicular traffic; and
- Because it comes from loudspeakers at both ends of crosswalks, they may be able to home in on it as they complete their crossing.

Disadvantages:

- The sound is relatively loud, possibly masking the sound of critical traffic movement,
- The clearance interval sound might be mistaken for the WALK signal.

It is particularly important that pedestrians who are blind not mistake a clearance interval signal for a WALK signal, as they could begin crossing late in the clearance interval when they would not have enough time to complete crossing before the onset of perpendicular traffic.

Reference

PROWAAC X02.5.2.2 G.

MUTCD states that the APS shall indicate the walk interval.

Clearance Interval tones

How used

This feature is not currently used in the US and is not recommended due to the potential confusion of the WALK interval with the clearance interval.

Developing features

Integrated information devices

The increasing use of personal pagers, cellular telephones, and other mobile digital communications devices that could potentially receive transmitted pedestrian signal messages suggests that there may be other technologies and methods to provide information to pedestrians and for pedestrians to call the WALK interval in the future. Development is ongoing on an integrated handheld computer type device to provide geographic, GPS, intersection layout and real-time signal information to pedestrians who are blind as they travel. Communication of a pedestrian call is also being investigated. However, such technology is in the very early development stages.

Pedestrian countdown information

Pedestrian signal heads that provide pedestrian countdown information have been installed in many municipalities in the past year.

Provision of the countdown information to individuals who are blind or visually impaired in an audible verbal message format has been discussed. However, the provision of audible information during the clearance interval, as discussed in the section on clearance interval information, may mask traffic sounds that are important, or may be confused with the walk interval. In fact, a pedestrian who is blind is usually moving as quickly as possible to cross the street, and knowing the length of time left may not provide any additional information.

Pedestrian countdown information is unlikely to provide any advantage to the individual who is blind or visually impaired. Any provision of audible countdown information should be carefully evaluated before installation. At this time, it is not recommended

Developing Standards and Guidelines

Current

Standards and guidelines on APS in the U.S. are rapidly developing in response to research demonstrating that

- access to public rights-of-way is severely limited by lack of accessible pedestrian signal information at some intersections; and
- this lack of information can lead to unsafe crossings by pedestrians who are blind.

Standards and guidelines are also changing in response to recent and on-going research projects that may provide more definitive information on which to base technical specifications for APS equipment and its installation.

Existing standards, recommendations and draft guidelines include differences in language, recommendations, and requirements that reflect the changing state-of-the-art.

Current recommendations are included in:

- MUTCD
- (ADA) *Draft Guidelines for Public Rights-of-Way*

MUTCD

The MUTCD 2000 contains two sections on Accessible Pedestrian Signals, Part 4E.06, Accessible Pedestrian Signals, and Part 4E.08, Accessible Pedestrian Signal Detectors.

Draft Public Rights-of-Way Accessibility Guidelines

Minimum guidelines and requirements for implementing the ADA in public rights-of-way will be issued as a Notice of Proposed Rule-Making in 2003.

Draft guidelines based on the PROWAAC Report were published on June 17, 2002 for comment.

Manual on Uniform Traffic Control Devices - MUTCD

National standards	All states must conform to the MUTCD standards when installing any traffic control devices. Changes made by FHWA to the MUTCD must be adopted within 2 years, unless otherwise noted in the Final Rule.
Text headings and language conventions	**Standard** – required, mandatory, or specifically prohibitive practices regarding a traffic control device. The verb **shall** is used. **Guidance** – recommended, but not mandatory, practice in typical situations, with deviations allowed if engineering judgment or study indicates deviation to be appropriate. The verb **should** is used. **Option** – permissive condition; carries no requirement or recommendation. Allowable modifications to a Standard or Guidance. The verb **may** is used. **Support** – informational statement. Does not convey any degree of mandate, recommendation, prohibition, or enforceable condition.
Where required	MUTCD offers guidance regarding factors to consider in an engineering study in deciding whether an APS is needed. Factors include: • "Where required potential demand for APS • A request for APS • Traffic volumes during times when pedestrians might be present; including periods of low traffic volumes or high turn-on-red volumes • Complexity of traffic signal phasing • Complexity of intersection geometry."
Avoidance of ambiguity	Several statements address ambiguity: • "Information provided by an APS shall clearly indicate which pedestrian crossing is served by each device." • "When used, verbal message shall provide a clear message of the walk interval and to which crossing it applies." • "Technology that provides different sounds for each non-concurrent signal phase has frequently been found to provide ambiguous." • "Pushbuttons should clearly indicate which crosswalk signal is actuated by each pushbutton." • "In choosing audible tones, possible extraneous sources of sound should be considered."

Manual on Uniform Traffic Control Devices - MUTCD

WALK indication

Standards:

- If APS have tones, they shall have a tone for the walk interval
- WALK tones shall have a faster repetition rate than an associated pushbutton locator tone
- Shall operate day and night
- If used, verbal message for a WALK signal shall be the term "Walk sign."... may be followed by the name of the street to be crossed
- Vibrotactile devices, where used, shall indicate that the WALK interval is in effect...shall indicate for which direction the signal applies, through the use of a vibrating directional arrow or some other means, shall be located next to, and on the same pole as, the pedestrian pushbutton, and adjacent to the intended crosswalk

Volume

Volume: Audible tones shall be audible from the beginning of the associated crosswalk.

- WALK tones should be no louder than the locator tone.
- WALK signals and locator tones should respond to ambient sound, be no more than 5dB louder than ambient sound, and be 89 dB max.
- Locator tones should be audible 6 to 12 feet from the pushbutton or to the building line, whichever is less.

Pedestrian pushbuttons

Pushbuttons:

- Shall activate both the walk interval and the accessible pedestrian signals
- Pushbuttons and arrows should contrast with the housing
- Locator tones shall be easily locatable
- Locator tones shall repeat at one-second intervals for a duration of .15 sec max

At locations with pre-timed or non-actuated signals, pushbutton may be used to activate the APS.

Manual on Uniform Traffic Control Devices - MUTCD

Location of pushbuttons

Pushbuttons:

- Adjacent to a level all weather surface
- Accessible route to the curb ramp
- Within 5 ft (1.5 m) of the crosswalk extended
- Within 10 ft (3 m) of the edge of the curb, shoulder, or pavement
- Where two APS pushbuttons are located on the same corner, the pushbuttons should be separated by a distance of at least 10 ft (3 m)

Pushbutton signage

Tactile arrows:

- Should be oriented parallel to the associated crosswalk
- Should have high visual contrast

The name of the street in Braille may be provided.

Audible beaconing

The audible tones may be made louder for the subsequent pedestrian phase, up to a max of 89dB, by holding down the pushbutton for a minimum of 3 seconds.

- May also alternate back and forth across the crosswalk to provide optimal beaconing

Other

When used, APS shall be used in combination with pedestrian signal timing.

A verbal message when the WALK signal is not on shall be the term "Wait."

If the pedestrian clearance time is sufficient only to cross from the curb to a median (of sufficient width for pedestrians to wait) and accessible pedestrian detectors are used, an additional accessible pedestrian detector should be provided in the median.

Draft Public Rights-of-Way Accessibility Guidelines

Where required	Guidelines will apply to new construction or planned alterations at signalized intersections Each crosswalk with pedestrian signal indications shall have a signal device that includes audible and vibrotactile indications of the WALK interval.
Avoidance of ambiguity	Not specifically addressed.
Walk indication	Specifications of the walk indication: • Audible and vibrotactile indications of the WALK interval • Audible indication by voice or by tone • Tones shall consist of multiple frequencies with dominant component at 880 Hz; duration of .15 seconds and shall repeat at intervals of .15 seconds
Volume	Measurement of the volume for walk indication and locator tone: • Tone or voice volume measured at 36 inches, 2dB minimum and 5dB maximum above ambient noise level • Responsive to ambient noise level changes
Pedestrian pushbuttons	Pushbuttons: • Integral with the APS device ✓ • Shall have locator tones which operate during the flashing and steady DON'T WALK intervals • Locator tone shall repeat at one-second intervals for a duration of .15 sec max • Force required of 5 lbs maximum, operable with one hand, not require grasping twisting or pinching • Control face shall be installed to face the intersection and be parallel to the direction of the crosswalk it serves • Minimum 2 inches across, contrast visually with housing

Draft Public Rights-of-Way Accessibility Guidelines

Location of pushbuttons	Specifies location: • Located at a level landing connected to the pedestrian access route • 60 inches (5 ft) maximum from the crosswalk lines extended • 120 inches (10 ft) maximum and 30 inches (2.5 ft) minimum from the curb line • 120 inches (10 ft) minimum from other pedestrian signal devices at the crossing
Pushbutton signage	Tactile and visual signs on the face of the device or its housing indicating crosswalk direction and the name of the street containing the crosswalk served by the pedestrian signal: • Should comply with specifications for Braille and raised print • Tactile arrow aligned parallel to the crosswalk direction and specifications for arrow size • Arrow should contrast with the background • Where provided, graphic indication of the crosswalk shall be tactile and characters shall contrast with background
Audible beaconing	Not specifically mentioned although ‘additional features’ are permitted.
Other	Extended button press permitted to activate additional features, buttons of devices with additional features shall be marked with symbol comprised of three Braille dots forming an equilateral triangle.

Experiential Exercise

Purpose	The intent of this exercise is to familiarize the participants to the different APS devices. The participants will be given the opportunity to demo the units and ask questions of each demonstrator while rotating from station to station.
Materials	Manufacturer's units and brochures (as available): • Campbell Company • Georgetown Electric, Ltd. • Mallory Sonalert Products, Inc. • Novax Industries, Inc • Bob Panich Consultancy Pty. Ltd. • Polara Engineering • Prisma Teknik AB • Relume Corporation • Talking Signs, Inc. • U.S. Traffic Corporation • Wilcox Sales Company
Small groups	Participants will be divided into small groups and circulate to the stations within the room. The demo units will be grouped by type and features.
Demonstration of units	The person in charge of that station will demonstrate the units. The demonstrator will first provide an example of all the features available with the unit and then provide the hands-on experience. The person in charge will also facilitate communication and answer questions as they arise.
Group discussion	The group will reconvene to continue discussion regarding APS technology and how to initiate crossings at an intersection where APS are installed.

Crossing at an Intersection Where APS are Installed

Introduction

This section provides instructional information on the use of an APS for pedestrians who are blind or visually impaired.

APS is supplement to other cues

The skills utilized in determining the type of traffic control, intersection geometry, and WALK interval at intersections that do NOT have APS will still be used at intersections that have APS.

The information provided by an APS should be verified with traffic movements and other environmental cues. Crossing on the first WALK interval utilizing an APS alone is not recommended, especially at intersections that are new to the pedestrian.

Maintain initial alignment

When approaching an intersection with an APS installed.

Pedestrians who are blind should:

1. Proceed to the corner maintaining their initial alignment
2. As they near the end of the block, they should be attentive to a possible locator tone and note its location and continue walking to the perpendicular street
3. Locate the curb ramp or curb and notice any tactual landmarks which may help them return to that location
4. Notice alignment and determine how to re-align there again quickly (perhaps without any traffic sounds) after pushing the button
5. Evaluate the intersection. Don't cross immediately, even if they hear what might be an audible indication of the WALK interval

Interpret traffic

Use the sounds of vehicles to

- interpret traffic patterns and assess the overall geometry of the intersection; and
- determine the signal phases, if possible, and the type of traffic control.

Try to determine if the intersection has pedestrian actuation (via pushbuttons). If there is no locator tone that alerts them to the pushbutton location, a systematic search pattern should be used to locate poles near the intersection. When a pole is found, it should be searched to see if it has a pushbutton or pushbuttons on it.

Crossing at an Intersection Where APS are Installed

APS

Assess whether an APS device is installed at the intersection.

- If there is a tone or speech that seems to be related to the pedestrian signal, evaluate which traffic it applies to and if it repeats every cycle. If it seems inconsistent, look for a pushbutton and explore it to determine if it is accessible.
- If there is a repetitive tone, with a once per second repetition rate, at the corner, it may be an APS locator tone. Localize the sound and move to its source.

Explore the APS

In order to maintain orientation, pedestrians who are blind or visually impaired should repeatedly "shift" focus between exploring the APS and the traffic information

Exploration:

- Does the device have an arrow? If so, what direction is the arrow pointing? Does this match the flow of parallel traffic?
- Does the device have a locator tone; and WALK tone, if so, what are the sounds?
- What happens when you push the button? Is there some type of signal that tells you the button has been pushed? This may be a click or tone or a pushbutton message.
- Does the device have speech messages?
- Hold the button in for 3-4 seconds. Is additional speech information provided? If so, what type of information does it provide? Push and hold the pushbutton for 3 or more seconds to see if that calls the audible walk indication, a pushbutton message, or a louder walk tone.
- Does the device have Braille or raised print signage? If so, does the sign assist in directional purposes?
- Does the device have a tactual map? If so, do the characteristics of the environment fit the tactile images on the map?

Decipher tones or speech messages

While listening to traffic, determine if the tones or speech messages correspond with the changing traffic patterns. It is imperative that the correct directional traffic surge moves congruently with the sound of the WALK interval

Crossing at an Intersection Where APS are Installed

Realignment

Once the APS has been thoroughly explored and it has been determined that traffic patterns correspond with the audible information provided, pedestrians should press the button and return to the curb at the predetermined spot for alignment. Maintaining initial alignment may help in crossing on the next WALK interval. However, the predetermined spot for alignment may not prove beneficial if the pedestrian explores an APS with a tactual arrow that conflicts directionally with the location of the predetermined spot.

If unable to cross in the next walk interval, pedestrians need to return to the pushbutton and press it again to call the walk for the next cycle.

Crossing

Additional cues and sounds from parallel and perpendicular traffic and other pedestrians should be used to confirm the information from the APS as well as to maintain alignment while crossing.

Either visually or auditorally, pedestrians should confirm that no vehicles are approaching quickly with no intention of stopping before stepping into the street to begin crossing and should continue to listen for turning cars while crossing

When approaching the last lane of traffic, if there was a locator tone, pedestrians should begin listening for a locator tone of the APS on the destination corner. It may be useful for alignment purposes.

Module 5

Strategies for Integrating APS Into Existing Signal Systems

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Objectives – Module 5 – Strategies for Integrating APS Into Existing Signal Systems

Traffic Signal Controllers (8 minutes)	Participants will gain a better understanding of the issues discussed in previous sessions and learn about the common types of traffic signal controllers used in the U.S.
Traffic Signal Phasing and Detection Used with APS (7 minutes)	Participants will review and discuss how traffic signal phasing affects APS operation and how various pedestrian detection technologies are integrated. Developing pedestrian detection strategies (ITS technologies)
APS/Traffic Signal Controller Interface (10 minutes)	Participants will learn how APS devices interface with traffic signal controllers.
Questions to consider (20 minutes)	Questions to consider in deciding appropriate type and features • Intersection signalization • Pushbutton and pole location • Intersection geometry and need for audible beaconing • Issues of sound placement and possible confusion • Preference and requests of individuals who are blind or visually impaired
Lessons Learned from Existing APS Installations (30 minutes)	Participants will recognize some of the engineering decisions, and issues learned from those who have installed APS devices in their community. Pictures of installations and videotapes of intersections will be used to further enhance the group's discussion regarding selection strategies
Funding (5 minutes)	Participants will learn how agencies are funding APS installations.

Traffic Signal Controllers

Purpose

Traffic signal controllers are essentially roadside computers that implement the signal timing and pedestrian calls by defining phases and sequences, cycle lengths, and phase splits.

- Controllers are connected to the signal display hardware (traffic signal displays (e.g., traffic lights), pedestrian heads) that inform drivers, bicyclists and pedestrians of the signal control plan being implemented.
- In demand responsive intersections (semi-actuated, actuated), detectors are connected to the controller to provide information on vehicle and pedestrian presence that will interact with the controller to determine various signal timing patterns.
- When the adjacent signalized intersection is coordinated with other intersections along an arterial, the controller will include arterial and system control hardware.

Basic Controller Types

In general, there are two basic types of traffic signal controllers for signalized intersections; pre-timed and actuated.

Traffic Signal Controllers

Pre-timed Controllers

As the name implies, pre-timed controllers operate on a predetermined schedule. Commonly used in locations with predictable traffic patterns such as downtown areas. Because the phasing times are fixed, significant problems can develop with short-term fluctuations in traffic demand. Common characteristics include:

- Provides constant cycle lengths, phase sequences, and phase lengths, as implemented by the traffic engineer
- Can provide for several different pre-timed timing patterns and/or phase sequences for different times of the day
- Function without respect to traffic demand and requires no detection
- Common types of pre-timed controllers are electromechanical; a synchronous motor turns at a fixed rate and drives a timing dial through a timing gear. The timing gear determines the rotation speed of the timing dial, and thus the cycle length, which comprises one rotation of the timing dial. A number of keys are inserted in the timing dial, each which lifts and closes switches within cams to activate circuits that turn on and off the various signal indications.

Modern controllers (actuated) can operate in a pre-timed mode through the use of maximum phase times and recall switches.

Traffic Signal Controllers

Actuated Controllers

Actuated controllers operate with variable vehicle timing, pedestrian timing and phasing intervals that depend on traffic volumes and the presence of pedestrians. Common characteristics include:

- Allow cycle lengths, phase sequences, and phase lengths to change on a cycle-to-cycle phase based on traffic and pedestrian demand
- Require detection on all approaches and pedestrian crossings to provide information on vehicle and pedestrian arrival and presence
- Green times can vary during each cycle within a given minimum and maximum green time
- Phases can be skipped in cycles where they are not needed
- Yellow change and all-red clearance intervals are preset for each phase
- Recall switches can be used to determine where the green indication will stay when no demand is present, or allow the signals to cycle on a fixed-timed basis
- Most common controller type today

Actuated Controllers

Actuated Controller Types

Actuated traffic signal controllers are based on the National Electrical Manufacturers Association (NEMA) or Type 170 standards. Three main types:

- NEMA
- Type 170
- ATC

NEMA

Traffic Control Systems Section within NEMA charged with setting manufacturing guidelines and standards for traffic control hardware, began in 1976.

- Controller software preloaded into the controller and not programmable.
- Two types of platforms, TS-1 (1976) and TS-2 (1992). The TS 2 standard defined two types of controllers, the TS 2 Type 1 and TS 2 Type 2.
  - The TS 2 Type 1 controller is unique in the sense that is uses a separate connection to the peripheral devices, with a separate power connector.
  - The TS2 Type 2 provides the same connectors as the TS 1 but also includes the separate connection to the peripheral devices. This allows the TS 2 Type 2 controller to be installed in TS 1 cabinets, reducing the upgrade costs.
- Most common standard used in U.S.

Actuated Controllers

Type 170

Initially developed in California and New York in 1979.

- Designed to meet the needs of current and future controllers by developing a hardware standard.
- Rather than require hardware modifications (like NEMA), Type 170 controllers can be changed to respond to new traffic and pedestrian conditions through software changes.
- Programmable software designed and loaded into the controller for operation.
- Several generations have been developed since 1979, including the 179 (New York, 1985), 170E (Caltrans, 1990), and 2070 (Caltrans, 1995). Each provided improvements in processing power, memory, and communication capabilities.

Advanced Traffic Controller (ATC)

New generation of controller currently being developed, combining the NEMA, Type 170 and Type 2070 concepts with new ideas.

- ATC controllers use an open architecture, interchangeable between manufacturers. Open architecture will also provide additional applications, with the possibility of running multiple applications on one ATC controller.
- Updates controller systems with current ideas and technology.
- The ATC standard provides flexibility in hardware development, allowing hardware changes to evolve with technology.
- Interchangeability between manufacturers is strongly emphasized including connectors, user interface, software, communications, internal networks, and computer and modem modules.

The flexibility developed with the ATC standards will allow an ATC controller to work in intersection control, real-time surveillance, transit systems, communications hubs, field masters, ramp metering, sign control, ITE beacons, video systems, environmental systems, and weigh-in-motion applications.

Other Controller Components

Other hardware

Other detector hardware is included in the cabinet if different detection technologies are used.

Malfunction Management Unit (MMU) or Conflict Monitor

The MMU (NEMA TS 2), or conflict monitor (NEMA TS 1, Type 170), is a device that works with the traffic signal controller to prevent basic operational problems. MMUs look for conflicts, signal failures, improper operating voltages, miswirings within the cabinet, signal indication failures (burnt light bulbs) and other operational problems, the most concerning of which is green indications presented to conflicting movements.

When a problem is detected, a message is sent to the controller, and the intersection is placed into a flashing mode until appropriate maintenance can be completed.

Loop Detector Amplifiers

With the common use of inductive loops for vehicle detection, loop detector amplifiers are almost always included in the traffic controller cabinet.

- The loop detector wire is connected to the electronic amplifier (located in the controller cabinet), which in turn is connected to the controller.
- Current passing through the loop wire creates a tuned electrical circuit, with a fixed level of inductance.
- Metal within a vehicle passing over the loop will unbalance the tuned circuit, creating a change in inductance, which is sensed by the loop detector amplifier.

The presence or passage of a vehicle message is sent to the controller.

Different settings are available on a loop detector amplifier to adjust the type of detection (presence, passage), frequency, sensitivity, and various delay or extension modes.

Traffic Signal Phasing

Phasing

Phasing plans for a traffic signal can range from a very simple two-phase plan to a complicated multi-phase operation.

Modern traffic signal controllers give the traffic engineer tremendous flexibility in dealing with variations of vehicle and pedestrian demand. Controllers can vary the cycle length and green times, and can change the order of phases or skip phases if demand dictates.

Phasing Development

The key aspect to any phase plan involves a determination of which turn movements (left, right) require protection (i.e., separate phase). Pedestrian considerations are also important and must be included in phasing development.

Several points considered in phase plan development:

- Phasing should minimize hazards/risk by separating competing movements; however, additional phases can increase vehicle and pedestrian delay and decrease efficiency
- While increasing the number of phases will increase the amount of lost time each hour (delay), the potential increase in saturation flow rates (i.e. efficiency) may offset this effect. Safety improvements may be gained by separating movements
- The phase plan must be consistent with the intersection geometry, lane use assignments, traffic volume and speeds, and the pedestrian crossing requirements
- A phase plan must be implemented in accordance with the standards and criteria of the MUTCD, and must be accompanied by the necessary signs, markings, and signal hardware to identify appropriate lane use, movements, and pedestrian control

Two-Phase

Two-phase operation is the simplest and most widely used:

- Each street receives one phase during which all movements, including pedestrian movements, are made

All left-turns and right-turns are made on a permitted basis (i.e., through acceptable gaps in the opposing traffic and pedestrian streams).

Traffic Signal Phasing

Three-Phase Three-phase adds left-turn protection (phase) to the two-phase plan:

- Both left-turns on the main street are provided with a simultaneous and exclusive phase, most often before the through phase
- Generally requires left-turn volumes greater that 100 vehicles per hour (vph)
- Can also be accomplished using leading and lagging left-turns
  - One direction of the main street is released while the other is held. Since the opposing flow is stopped, left-turns from this approach are protected
  - Followed by a phase in which the second through movement is started and allowed to move simultaneously with the first. During this interval, left-turns are permissive (or can be prohibited)
  - Initial movement is stopped while the opposing flow continues, giving the second left-turn movement protection
  - The side street is then accommodated under one phase

Traffic Signal Phasing

Three phase: Problems with Lead-Lag left turn phasing

Lead-lag left-turn phasing can be beneficial for vehicle progression but may cause a problem with a phenomenon called the "yellow trap."

The typical yellow trap occurs when:

- a signal changes from the permissive left-turn intervals in both directions to a lagging protected movement in only one direction;
- A driver attempting to make a left turn on the permissive circular green indication becomes trapped in the intersection when their circular green indication turns yellow for the change interval;
- The left-turn driver, who is attempting to clear the intersection, also sees the adjacent through lanes receive the circular yellow indication; and
- The left-turner mistakenly believes that the opposing traffic now has the yellow change interval and makes the left-turn.

The yellow trap occurs because the opposing traffic does not receive a yellow change interval, but instead has a circular green indication in the through lanes and a protected left-turn arrow indication. The potential for serious conflict occurs between the sneaker left-turning vehicle and the opposing, non-stopping through traffic.

Traffic Signal Phasing

Four-Phase

A four-phase operation can be created by providing an exclusive left-turn phase for both streets:

- Can also be accomplished by using any three-phase combination with an exclusive pedestrian phase

Eight-Phase

New controllers provide at least eight phases of operation. Up to 16 phases can be provided with varying phase overlaps:

- Many different phasing combinations can be developed to make up the eight phases
- A typical eight phase sequence includes:
  - An initial dual left-turn phase for north-south direction
  - A leading green phase in which one left-turn phase is stopped while the other is allowed to continue. The choice of which left-turn movement is terminated first is based on demand, and can vary from cycle to cycle. The length of the left-turn phase and continuation left-turn time is based on demand
  - Left-turns are stopped and both through and right turns are processed
  - Process is repeated for east-west movement

Vehicle Detection

Vehicular detection technologies

A number of different technologies are used for vehicle detection. These include:

- Inductive loops
- Magnetic detectors
- Ultrasonic
- Microwave
- Infrared
- Video

Inductive Loops

Loops are typically formed by two to three turns of a 12-guage or 14-gauge wire placed in slots cut in the pavement:

- Wire travels back to the loop detector amplifiers, located in the controller cabinet near the controller
- The loop is energized with low current electrical flow creating a tuned circuit in a steady-state of inductance
- A vehicle passing over or stopping on the loop causes an unbalance in the tuned circuit and reduction in loop inductance
- The change in inductance is detected by the loop detector amplifier; the appropriate message is sent to the traffic controller

Magnetic Detectors

Device imbedded in the pavement similar to loop detectors:

- Based on the earth's magnetic forces
- A vehicle passing over or stopping on the magnetic device deflects the constant lines of magnetic flux, causing voltage to be developed
- The change in magnetic field is detected, sent through the lead-in cable to an amplifier in the controller cabinet, and the appropriate message is sent to the traffic controller

Vehicle Detection

Ultrasonic	Provides an alternative when pavement conditions prevent the installation of loops or magnetic detectors: • Device sends an ultrasonic wave to the pavement from an overhead mounted location • Wave is reflected back to the source • The time for the wave to reach the pavement and reflect back is measured and calibrated • When a vehicle is in the detection zone, the ultrasonic wave is reflected off of the vehicle instead of the pavement causing the wave to return sooner • The shorter wave reflection time sends a message to a sensor in the controller cabinet which in turn sends a message to the controller indicating the presence or passage of a vehicle
Microwave	Sensors mounted overhead: • Uses the "Doppler effect" for detection of moving vehicles • Microwaves are beamed towards the roadway by a transmitter • A vehicle passing through the beam reflects the microwave back to the antenna at a different frequency • Detector senses the change in frequency, denoting the forward movement of a vehicle • Provides a large detection area • Requires FCC license • Can be used for pedestrian detection
Infrared	Works on the same principle as the ultrasonic except that infrared lasers are sent to the pavement and reflected back: • Two active-infrared laser sensor beams are projected to the pavement, separated by several degrees • Vehicle presence and speed are determined by the time each beam is entered • Modern active infrared devices that use laser sensors produce two- and three-dimensional images suitable for vehicle classification • Requires a rigid mount • Potential adverse reaction to weather and light conditions

Vehicle Detection

Video

A wide-area video image of the detection zone is captured from an overhead camera

- Cameras mounted 30 to 50 feet above the roadway
- Detector locations are defined within the video image
- Vehicles are detected as the light intensity of the image on the pictals changes in the defined detector zones
- An appropriate detection message is sent to the traffic controller

Developing Pedestrian Detection Strategies - (ITS Technologies)

Description

Passive pedestrian detection is available to call the WALK indication and can extend the clearance interval.

Waiting area detectors may be either

- pressure mats with piezo-electric sensors;
- infrared or microwave detectors mounted on the signal pole; or
- video cameras serving remote sensor software .

The selected technology "observes" a designated area. When a pedestrian is detected, a call for a pedestrian phase is sent to the controller. In a passive detection scheme, the call remains without the need for manually pressing a pedestrian push button (assuming one exists).

If indeed there is a push button, after a pedestrian has pressed a push button to call for the WALK interval, detectors confirm the presence of pedestrians standing near the crossing. If the pedestrian changes his or her mind and leaves the intersection area before the onset of the WALK interval, the call for the pedestrian phase can be canceled. This is often referred to as "presence" detection.

Active infrared

Currently used to provide vehicle presence, volume, speed measurements, classification, length, and queue measurements. Recent developments have extended this technology to pedestrian and bicycle detection:

- Can be installed for both single and multi-lane approaches
- Ability to provide two- and three-dimensional images
- Graphical images can be produced for pedestrian classification
- One of the newer technologies that appears to be a promising technology for pedestrian detection in a multi-use facility

Developing Pedestrian Detection Strategies - (ITS Technologies)

Passive infrared	Automatically detects the presence of pedestrians in either the targeted curbside area or within the crosswalk: • When used to detect pedestrians in the crosswalk, its function is to detect the presence of individuals requiring additional time to cross, and accordingly extend the clearance interval and provide more time to cross • These detectors function by sensing changes in thermal radiation caused by movement within the field of view • A pedestrian entering the target area causes such a temperature change to occur, which in turn, is detected by the sensor. These detectors may either be used to supplement or replace the standard pushbutton used to activate the pedestrian call feature • Adversely reacts to all forms of inclement weather and light conditions
Microwave pedestrian detectors	Automatically detects the presence of pedestrians in a targeted curbside area and/or while moving in a designated crosswalk area: • Developed for signal actuation and safety • When used at the curbside area, it may either replace or augment the standard pushbutton • When used to detect pedestrians in the crosswalk, its function is to detect the presence of individuals requiring additional time to cross, and accordingly extend the clearance interval and provide more time to cross
Piezo-electric	Paving slabs which consist of weight sensitive rubber covering a piezo cable: • The weight of the object on the paving slab sends an electric signal through the piezo cable confirming detection • Used primarily for pedestrian detection • Systems are not portable • Installations are cumbersome • Use for pedestrian detection is limited

Developing Pedestrian Detection Strategies - (ITS Technologies)

Implications

Pedestrians who are blind or visually impaired:

- May not be aligning to cross in the detection area, thus may not be detected
- Must be able to locate the push button, or the waiting area and the crosswalk if such detectors are to be effective

In these and in similar systems that rely wholly on sensors to actuate the pedestrian phase, APS can indicate to the pedestrian that the pedestrian phase has been called and the onset of the WALK.

Other developing technologies

The increasing use of personal pagers, cellular telephones, and other mobile digital communications devices that could potentially receive transmitted pedestrian signal messages suggests that there may be other technologies and methods to provide information to pedestrians and for pedestrians to call the WALK interval in the future.

Development is ongoing on an integrated handheld computer type device to provide geographic, GPS, intersection layout and real-time signal information to blind pedestrians as they travel.

Communication of a pedestrian call is also being investigated. However, such technology is in the very early development stages.

APS/Controller Interface

APS/Traffic Signal Controller Interface

There is little interface directly between the APS and traffic signal controllers. The APS is generally driven by the pedhead indications. When current is sent to the pedhead to illuminate the walk indication, the APS device is also activated. All units currently available are wired to the pedestrian signal wiring.

Pedhead integrated units

- provide sound only during the walk interval;
- typically wired directly to the Walk indication, without other features or issues.

Pushbutton integrated APS:

- Have additional control units which may be installed (depending on the manufacturer and the device)
    - in the pedestrian signal head (16” clamshell style);
    - contained completely within the pushbutton unit;
    - installed in the traffic controller; or
    - in a separate housing which must be mounted on the signal pole.
- These control units control operation of the locator tone, pushbutton messages and other features available on the pushbutton integrated devices.

Receiver based devices:

- Vary depending on the type of signal:
    - – Talking Signs has a control board and transmitter mounted at the pedhead
    - – Relume is a replacement pedhead which is wired in a typical manner to the pedestrian signal wiring

Installation

Pushbutton integrated units

The control units for pushbutton integrated devices require additional wiring from the pedhead to the pushbutton, usually an extra pair of 18 or 22 gauge wires.

Each wiring requirement is quite similar.

Some examples of wiring requirements are presented below.

Campbell

Wiring is very similar to the Polara, described below:

- Eight conductor 22 awg 7/30 stranded wire is run from the pedhead to the pushbutton location
- The control unit (called a driver module) is placed in a clam shell-type pedhead
- The existing walk and don't walk wiring is connected to the driver module, along with the output connects to the speaker units, pushbutton, and microphone accessories

Installation

Polara

One control unit is required for each push button unit (i.e., APS device):

- The control unit is installed in a typical 16-inch person/hand clam shell type pedestrian head
- Control unit is powered from the “walk” and “don’t walk” 120 VAC in the ped head and converts voltage to 24 VDC (max.) to control the push button functions
- There is no direct wiring application between the controller and the push button unit (use the existing 14 awg pair already in place from the existing pushbutton; however, four pair (min.) six pair (des.) of 18-22 gauge wires must be run from the push button unit to the corresponding pedestrian head. These wire pairs are connected to the “vibrator”, “speaker”, “pushbutton” and “LED” connections on the control panel
- Three 12 to 18 awg wires are also run from the control unit to the pedestrian head power terminals for the “walk”, “don’t walk”, and “common” connections. This is the 115 VAC connections provided by the signal controllers load switch
- One wire is also required to connect the microphone located on the bottom of the pedestrian head to the control unit

For new/reconstructed intersections where new wire will be pulled, the control unit can be placed in the controller cabinet.

- The control unit for controller installation consists of a shelf mount card rack power supply base station that can hold up to four control units.
- One control unit is required for each walk phase.
- A single microphone can be used to control the audible sounds for all control units, or each control unit can have its own microphone.
- Four pair of 18-22 gauge wire are required to each push button unit.

Installation

Prisma

Prisma push button units are connected directly to the terminal wire connection in a typical mast arm. A seven wire cable is provided with the unit.

- Wires are connected to the typical push button terminal, red indication terminal, green indication terminal, neutral, and ground.
- Additional connections to power the sound.

Pedhead mounted devices

These APS devices typically work on the Cuckoo/Chirp system and are wired to the pedhead for the appropriate direction.

- They do not provide vibrotactile indication of the WALK. Additional components may be purchased from one manufacturer.
- Some manufacturer's products do not have automatic volume adjustment and do not respond to ambient sound.

Mallory Sonalert, Novax, U.S. Traffic, and Wilcox

Speaker/sound device is mounted on the pedhead:

- A small hole is drilled into the top of the pedhead or in the signal pole, and the device is connected
- Wiring is quite simple, a black wire (comes with the device) is connected to the walk indication terminal in the pedhead and a white wire is connected to a neutral terminal in the pedhead
- A PC board controls the sound type and volume levels
- When current is sent from the controller to illuminate the walk indication, the APS device is activated during the duration of the walk phase

Which Technology Fits?

Strategies

After an engineering study determines that APS should be installed, strategies for integrating an APS into the sidewalk environment need to address certain issues and/or questions. These questions facilitate the solution process by resolving which type of APS is most appropriate and which features are suitable.

Intersection Signalization

Actuated:

- How will the pedestrian know there is a pushbutton?
- How will the pedestrian find the pushbutton?
- How will the signal timing be adjusted to accommodate a pedestrian after the pushbutton is pushed?

Fixed timed:

- How or where does an APS get installed when there isn't a pushbutton?
- APS without a pushbutton will sound during the walk indication day or night at regular intervals. How will businesses, residents, etc. within close proximity respond to the installation?
- How will the pedestrian receive information if the fixed time signals are placed in flashing mode during off-peak hours?

Exclusive Pedestrian Phase timing:

More research needs to be done regarding APS installations at this type of intersection.

- Should there be 1 or 2 pushbutton integrated APS at each corner?
- If 1 device, can it have 2 arrows that cross at a right angle to show that the device is used for crossings in both directions?
- If 2 devices, what type of speech message is best?
- If 1 device, can speech be used to state that the WALK sign is lit for crossings in all directions?
- Intersections providing an exclusive pedestrian phase often allow diagonal crossing; how is directional information best presented?

Which Technology Fits?

Pushbutton and pole locations

Questions:

- Is existing wiring adequate for installation of the APS?
- How can the pushbutton and pole location fit within MUTCD recommended location of within 5ft of the crosswalk lines (extended) and within 10ft of the curb?
- Can the pushbutton and pole be located even closer?
- Are the pushbutton and APS in an unambiguous location?
- Are the pushbuttons located adjacent to a level all-weather surface, free of hazards or obstacles?
- Is there sufficient turning room for a wheelchair if the pedestrian must turn to push the button and then return to the crosswalk?
- If existing pole is in "poor" location, can a stub pole be installed? Are there other poles nearby which are more appropriately located than the signal pole?
- Does one type of APS adapt better to the location than other types, due to tactile arrow location or other device features?
- Depending upon pushbutton or pole location, should tones or speech messages be utilized?
- If multiple pushbuttons with APS on the same corner are to be installed, can they be separated by the standardized 10ft? If not, how will the two APS be installed on the same pole using speech to give the walk indication in order to reduce the possibility of confusion?

Intersection geometry and need for audible beaconing

Beaconing is not needed at many intersections but APS in the U.S. have been typically installed to beacon in the past.

Questions:

- Does the intersection warrant the use of beaconing? (See discussion of audible beaconing for suggested criteria)
- Is this intersection skewed or offset?
- Would audible beaconing create the potential for confusion? (possible at an intersection with channelized right turns or other free flowing lanes)

Which Technology Fits?

Issues of sound placement and possible confusion	Questions: • If using tones, what tones? If using speech messages, what is the wording of the walk message and the pushbutton message? • Does the simultaneous sound from speakers, particularly overhead, pose a problem for localization? When localization is difficult, will it be hard to determine which crosswalk has the walk indication? • Is the APS volume set at the appropriate level to avoid complaints from surrounding residents or businesses and still provide appropriate information to pedestrians who are blind or visually impaired?
Preference and requests	Questions: • Have the needs of individual requesting the APS been addressed? • Have the preferences of the blindness community regarding use of speech, tones, etc. been sought?

Lessons Learned from APS Installations

New technology

Not unlike any new technology, the first installation of new types of APS devices does not always operate flawlessly. There were issues to resolve with some of the devices. In addition, reports from older installations have brought up recurring problems that need to be addressed in installation. All of the issues were easily solvable. The following should provide information to prevent these problems from reoccurring. Some issues include:

- APS compatability with controller Malfunction Management Unit (MMU)/Conflict Monitor
- Wiring to pedhead and/controller
- Pushbutton installation
- Signal phasing
- Speaker positioning and volume
- Volume adjustment
- Pushbutton and pole location
- Tactile arrow location and position
- Use and wording of speech messages
- Braille signage and correct installation

Lessons Learned from APS Installations

APS compatibility

The following are some of the problems reported related to the compatibility of the APS devices and traffic signal controller. Problems relate to the MMU/Conflict Monitor, which is designed to evaluate voltages throughout the signal system. When unexpected voltages or voltages outside of a given range are detected, the MMU overrides the controller functions and places the signals into a flash mode until maintenance is performed.

The following have been reported by some cities and were resolved by manufacturers.

- APS compatibility with the MMU/conflict monitor is related to voltage issues. When unexpected voltages or voltages outside of a given range are detected, the MMU overrides the controller functions and places the signals into a flash mode until maintenance is performed. Some of the APS devices manufactured internationally were designed with different voltage standards or voltage ranges that differ from the current U.S. specifications. This problem was found with Prisma units and NEMA TS 1 Conflict Monitors and with Novax units. The problem is resolved by placing transducers in the system to reduce the voltage from the pedhead to the pushbutton location.
- In reducing the voltage requirements to the pushbutton, another issue has developed. In contrast to the above, a novel wiring methodology was used with a Novax installation to reduce the voltage to the pushbutton. Novax equipment will send 120 VAC to the pushbutton when 24 VDC or less is desired. A circuit to reduce the voltage was successfully created, but the resultant circuit was external to the pedestrian wiring and therefore undetectable by the conflict monitor. Conflicting pedestrian signals were not overridden by the conflict monitor in this installation nor were the signals placed into flash mode when a pedhead malfunction occurred. Novax is still working on reducing the voltage sent to the pushbutton.

Lessons Learned from APS Installations

Wiring

Some minor problems have been experienced with wiring and color code.

- Prisma, a Swedish company, uses a European wire color standard. Since this standard is not consistent with the U.S. NEMA color code standards, some wiring problems were created. Prisma has taken steps to resolve this problem.
- Prisma and Novax installations have also drawn concern from signal technicians over the high voltage sent to the pushbutton location. As mentioned, voltage to the pushbutton is 120 VAC, compared to 24 VDC typical. Technicians are concerned about pedestrian safety if the push button is damaged or the push button is taken off by a passing vehicle, and a pedestrian comes in contact with the live wires or electrically charged metal pole. Both manufacturers have explored methods to reduce this voltage demand.
- Some problems were initially found with the controller recognizing the pedestrian pushbutton actuation. Polara units have been found to work well with both the NEMA and 170 controllers, since both (along with the conflict monitors) are sensitive to electrical deficiencies. Nevertheless, a minor electrical short, not affecting a standard pedestrian push button, prevented a Polara unit installation from working properly. The electrical short was identified and removed.

Pushbutton installation and vibrotactile indication

When two APS pushbuttons with vibrotactile indications are installed on the same pole, they require insulation and a rubber gasket to eliminate vibrations generated from the other pushbutton.

A problem was experienced when two pushbuttons were on the same pole with no vibratory insulation. Pedestrians were unable to determine which pushbutton was vibrating, since it appeared both were.

Proper insulation of the pushbutton will prevent this problem from occurring.

Lessons Learned from APS Installations

Phasing

Signal phasing has been found to affect APS functioning in certain situations.

- An installation had a problem when the signals went into flash mode and the APS device remained in walk mode. This scenario presented an unsafe condition and message for pedestrians. This problem was resolved by correctly wiring the APS device into the controller/signal system so the controller logic and conflict monitor detected and changed the pedheads to the appropriate indications.
- A similar issue was found with the walk mode. When a phase rests in walk, AND the installer does not wish to have the walk indication constantly sounding, a pushbutton is usually added to start the accessible sound, speech or vibratory indications. This is usually not provided for sighted persons when crossing with the main street traffic (crossing the side/minor street) since that approach does not have vehicular actuation. The locator tone typically does not sound during the walk interval. Most APS can be set to provide the walk indication for a set time period, then return to the locator tone, however this needs to be specified and installed properly. When the APS device (pushbutton) is pushed, the accessible indication does not initiate until the next cycle, even though WALK may be displayed visually. When the pushbutton is pushed, appropriate messaging must be provided.

Lessons Learned from APS Installations

Volume adjustment

Although current standards call for the APS volume to only be 2 to 5 dB above ambient sound and for the locator tone to be heard from 6 to 12 feet from the pushbutton, volume is often set much louder than that.

- Installers are used to devices using audible beaconing and think that APS are supposed to loud enough to hear across the street.
- Another issue is that there is no easy way to measure the volume of locator tone and walk indication, because of the short duration of the tones or messages, the requirement to measure in relation to ambient sound, and the signal's quick response to ambient sound.
- For pushbutton integrated devices, the speaker is in the pushbutton housing. Location of the pushbutton and orientation of the speaker can be critical to hearing the walk indication at the crosswalk.

Another installation experienced another problem in adjusting the volume of an APS unit.

- They had used the pushbutton control units that install in the cabinet (versus the pedestrian head).
- The wiring was too small of a gauge to drive the speaker to provide a loud enough message (compounded by the pole and speaker being more than 10 feet back from the crosswalk).
- Manufacturer's guidelines and specification should be followed for proper operation.
- Speakers can be provided for each control unit.

Lessons Learned from APS Installations

Speech messages

The speech messages used for the walk indication, as well as the descriptive pushbutton message, must be understandable. Some problems reported:

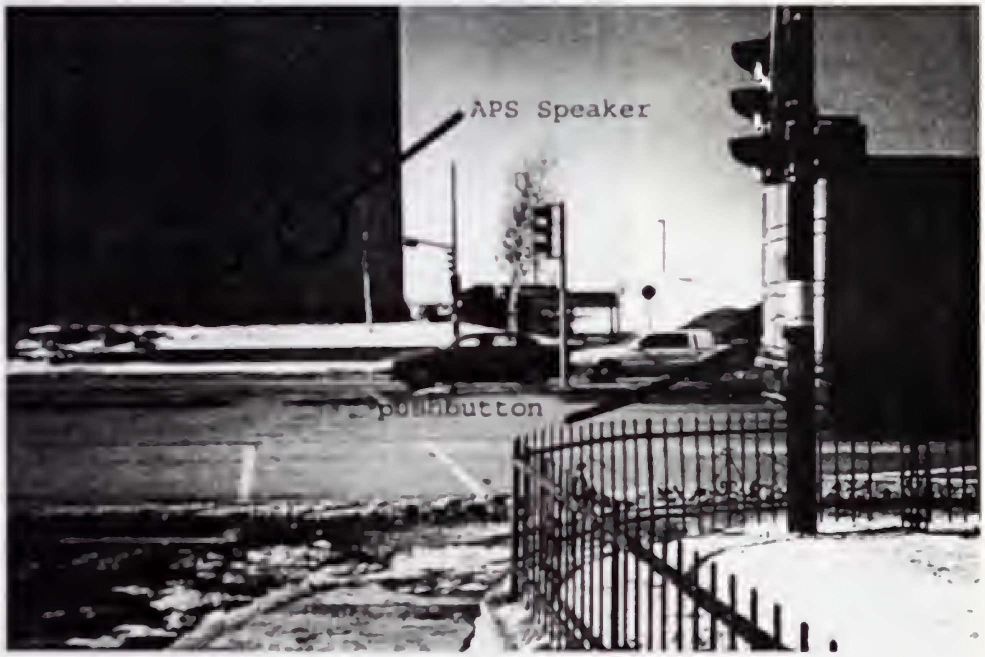
- An example of this was found at an intersection where the poorly recorded walk messages made the street names were indistinguishable [“Pratt” and “Calvert”].
- If the speech pushbutton message does not clarify which street the button applies to, the speech walk message using the street name does not clarify which street has the walk indication to the pedestrian who is unfamiliar with the intersection. For example, at the intersection of Harford and Taylor Streets, where the pushbutton message just said Harford and Taylor for all devices, the it was unclear if the message pertained to the street in front the pedestrian when the speech walk message stated: “Walk sign is on for Taylor.”
- Polk County Florida wanted to use a male voice for one crossing direction and a female voice for the other. The theory was that this difference would distinguish crossing directions and add to the safety of the crossing. Most APS devices provided a male voice only device. This problem was corrected by the manufacturer. Most devices provide self-recorded message capabilities now.
- Other minor problems relate to the recommended messages not being used; no standard walk message or standard pushbutton message. Older installations require updated messages consistent with current standards.

Lessons Learned from APS Installations

Pushbutton and pole location

The blind pedestrian must push the button, then go line up to cross the street. Some problems observed in locations of pushbuttons and poles of APS devices:

- Pushbuttons have been installed without locator tones. Blind pedestrians are unable to determine that there is a button they need to push and have difficulty locating the button
- Poles that are more than 10 feet from the curb line provide real problems with finding the pushbutton and then realigning to cross the street
- Pushbuttons are often placed in positions that are not reachable from the sidewalk area, or in the bushes, or behind a fence



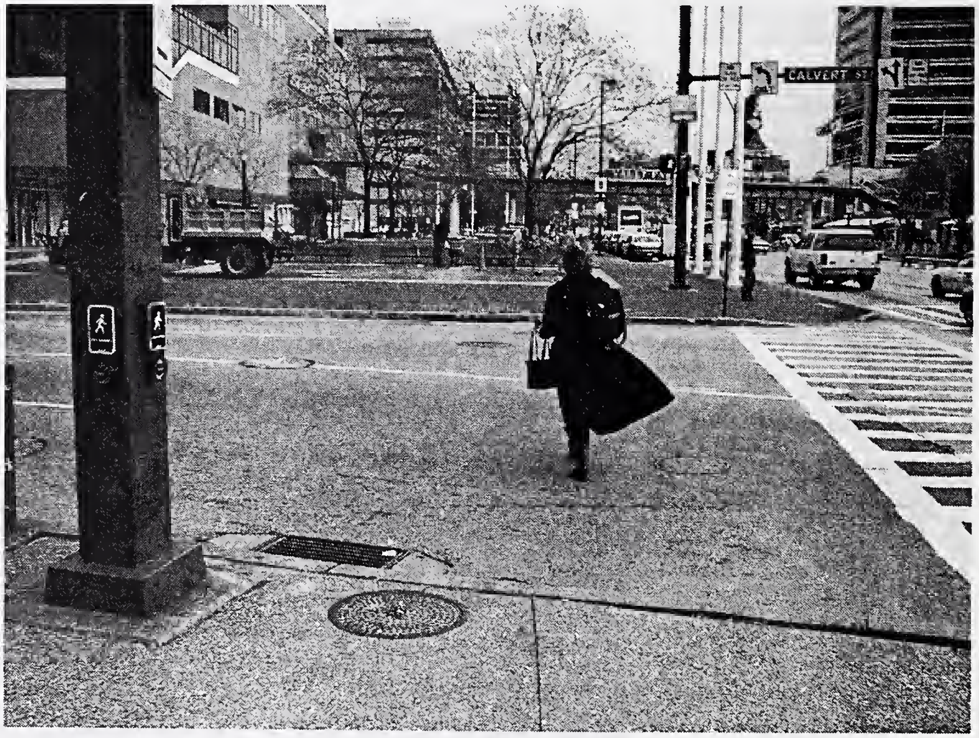
Lessons Learned from APS Installations

Tactile arrow and position

The tactile arrow is supposed to point in the direction of travel on the crosswalk and the face of the device is supposed to be parallel to the crosswalk it controls.

Some installation issues:

- If the pole is in a poor location, the arrow may be pointing at the street and crosswalk direction but not be within the crosswalk area.



- If installers do not understand the arrow's use, they may install it angled in the wrong direction. For example, if they use the holes from the previous pushbutton, the arrow may be pointing diagonally across the intersection rather than in line with the crosswalk.

Lessons Learned from APS Installations

Speaker positioning

Pedestrian head mounted speakers in existing installations are often mounted in positions that make the messages more ambiguous.

In the picture at left, the speaker is mounted and aimed straight down, on the pedhead which is facing the crosswalk, however, that pedhead is turned sideways and is directly over the waiting location and pushbutton to cross in the opposite direction. A pedestrian who pushes that pushbutton could be confused because the sound comes from directly overhead, but it is not the walk indication for the crossing controlled by that pushbutton.

A better installation is shown in the picture below, where the speakers are mounted on the side of the pedhead, but separated enough for the pedestrian to discern which speaker is sounding and aimed at the proper waiting location.

For pushbutton integrated devices, the speaker is in the pushbutton housing. Location of the pushbutton and orientation of the speaker can be critical to hearing the walk indication at the crosswalk. If the speaker is located too far from the crosswalk location, pedestrians who are blind may not hear the walk indication.

Lessons Learned from APS Installations

Braille signage and location	Braille indications on the pedestrian signals have been mounted backwards or with the Braille label for the wrong street. • Manufacturers ship them with a label to clarify positioning, however, later technicians may make adjustments to the sign and reverse or mix up the Braille plaques. • Adding the Braille makes it so the sign cannot be turned around without reversing the Braille. If the original specification was not correct, this limits the arrow direction and location.
Questions	Discussion of other installation issues and questions.

Funding APS installations

Funding

Adding APS devices to a typical traffic signal installation will add new costs; however, the small cost of the APS devices will most often be insignificant compared to the additional safety and mobility provided and the overall cost of a signalized intersection. Each APS device costs approximately $600. Installation cost will vary widely depending on the existing infrastructure, type of device and installation locations.

The cost of adding APS technology to all crosswalks at a signalized intersection range from $3,000 to $20,000, which included labor cost, depending on the age, complexity, and number of signal units associated with the signalized intersection.

- An installation in Maryland using Polara equipment was approximately $700 per unit and $3,000 per installation
- Installation of a Mallory-Sonalert APS device in Oregon was approximately $250 per unit plus two hour of labor.

Potential sources

Several potential funding sources can be used for installing APS units:

- TEA-21 funding
- Community development block grant funds
- Pedestrian safety improvement funds
- Private donors (used very successfully in Canada)
- General operating and maintenance funds

Most agencies have used general operating funds to include APS units with existing and new signalized intersections.

Module 6

Retrofitting an Intersection with APS

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Objectives – Module 6 – Retrofitting an Intersection with APS

Interactive design exercise (30 minutes)	Participants will gain a better understanding of the issues discussed in previous sessions by developing installation plans for APS at sample intersections
Discussion of decision (45 minutes)	In presenting and discussing APS installations at intersection configurations that can be difficult, participants will recognize some of the engineering decisions, choices available, and need for careful consideration and planning of installations.

Small Group Exercise – Develop installation plans

Purpose

Provide participants with the opportunity to apply information discussed in previous modules

Foster group discussion and decisions about

- installation locations;
- types of devices; and
- consideration of the issues to be resolved in installation decisions.

Small groups

Participants will work in small groups used in Module 3:

- 10 groups of 6, with approximately 3 engineers and 3 individuals who are knowledgeable about blindness or persons with disabilities.
    - 5 groups will work on plans for intersection A
    - 5 groups will work on plans for intersection B

Materials

Each group will have materials needed to work on redesign:

- Detailed intersection drawings and photographs, showing ROW lines, location of signals, poles, wiring and other constraints
- Information about scope of work
- Current signalization plans
- Prioritization rating forms which detail decisions about need for APS installations at crosswalks (previously made in Module 3)
- Tracing paper, markers, pencils, etc.
- Tactile maps and mapping materials, as needed

Small Group Exercise – Develop installation plans

Installation locations

Intersection A: T-intersection with high volume of traffic on the arterial street and low volume on the minor street (stem of T)

Intersection B: Plus shaped intersection with complex signal phasing including a free flow right turn lane.

Tasks

Interactive exercise (seminar leaders will circulate and observe, comment or ask questions, as seems appropriate)

Groups will decide type of APS to be installed, including

- details about the location of each APS at each crosswalk including the location of pushbuttons, pedestrian signal heads, and APS speakers;
- type of APS installed; and
- features to be provided.

Designate an individual to present their decision and explain the rationale for decision about location, type, message, and all features.

Presentation of installation decisions

Large group reconvened.

Intersection A:

- Groups 1-5 will present their solutions for intersection A
- Discussion of solutions and pros and cons, issues considered

Intersection B:

- Groups 6 – 10 will present their solutions for intersection B
- Discussion of solutions and pros and cons, issues considered

Questions

Discussion of other issues and questions.

Module 7
Glossary
and
Resources

GLOSSARY

The below listed definitions are specific to the curriculum modules. Glossary terms taken from Section 4A.02 Definitions Relating to Highway Traffic Signals of the Millennium Edition of the *Manual on Uniform Traffic Control Devices* are represented with (MUTCD) following the definition. Further explanations, which are not part of the MUTCD, have been added for clarification to some terms.

AASHTO - American Association of State Highway and Transportation Officials: responsible for publication of "The Green Book". (*A Policy on Geometric Design of Highways & Streets*) which is the premier resource on intersection geometry.

ACB - American Council of the Blind, a membership organization of people who are blind or visually impaired.

Access Board – Short name for the independent federal agency responsible for developing accessibility guidelines under ADA. Also referred to as the U.S. Architectural and Transportation Barriers Compliance Board (ATBCB).

Accessible Pedestrian Signal (APS) – A device that communicates information about pedestrian timing in nonvisual format such as audible tones, verbal messages, and/or vibrating surfaces. (MUTCD) The primary function of an APS is to provide information about the Walk interval in a format that is accessible to pedestrians with visual impairments.

Actuated operation – A type of traffic control signal operation in which some or all signal phases are operated on the basis of actuation. (MUTCD) At actuated intersections, the controller (computer) adjusts the signals to ensure maximum efficiency of traffic movements, based on the volume of vehicles and pedestrians detected at the intersection at that particular time.

Actuation – Initiation of a change in or extension of a traffic signal phase through the operation of any type of detector. (MUTCD). One example would be when several vehicles on a minor street are stopped at a red signal and their presence is detected, the controller will change the signal to green and give the major street a red signal. The length of the green signal on the minor street depends on the number of vehicles on that street.

Actuation indicator – See Pushbutton actuation indicator.

ACVREP – Academy for Certification of Vision Rehabilitation and Education Professionals. A certification body for professionals who work in education and rehabilitation of individuals who are blind or visually impaired.

ADA – Americans with Disabilities Act, Public Law 226. Federal civil rights statute that prohibits discrimination against persons with disabilities. Requires public entities and public accommodations to provide accessible accommodations to persons with disabilities. ADA Draft Guidelines for Public-Rights-of-Way Accessibility Guidelines were issued in June 2002.

ADAAG - Americans with Disabilities Act Accessibility Guidelines. ADA standards for accessible designs for buildings and facilities. Written by the Access Board and adopted and enforced by the DOJ and DOT.

AER - Association for Education and Rehabilitation of the Blind and Visually Impaired, membership organization of professionals who work with persons with visual impairments in education and rehabilitation settings.

Alert tone – A feature on a pushbutton-integrated APS that provides a brief burst of high frequency sound to alert pedestrians to the beginning of the Walk interval.

Alignment – Aligning one's body and mentally projecting a straight line across the street toward the destination corner. Pedestrians who are blind use auditory and tactile information to align their bodies for street crossings. Engineers also use the term alignment in talking about roadway alignment.

ANSI – American National Standards Institute. ANSI A117 provides technical specifications for making buildings and facilities accessible to persons with disabilities.

APBP - Association of Pedestrian and Bicycle Professionals, professional membership organization.

Approach – All lanes of traffic moving towards an intersection or a mid-block location from one direction, including any adjacent parking lane(s). (MUTCD) Thus, a plus shaped intersection has 4 approaches. A T-shaped intersection has 3 approaches.

Arterial street – A general term denoting a street primarily used by through traffic, usually on a continuous route or highway designated as part of an arterial system. (MUTCD)

ATBCB - U.S. Architectural and Transportation Barriers Compliance Board. Short name is Access Board.

ATI - Association of Travel Instruction, membership organization for professionals who provide travel instruction to persons with disabilities other than blindness.

Audible beacon – A sound source that is used to provide the pedestrian with additional directional and alignment information for street crossings. A beacon is intended to help a pedestrian who is blind find the destination corner.

Automatic volume adjustment – A volume control feature on an APS that provides automatic response to ambient sound. Also called automatic gain control (AGC).

Average day – A day representing traffic volumes normally and repeatedly found at a location, typically a weekday when volumes are influenced by employment or a weekend when volumes are influenced by entertainment or recreation. (MUTCD)

Button actuated timer (BAT) – A feature on APS that may activate the APS, additional information, or features after the pushbutton is pressed down for 1-3 seconds. This is one manufacturer's term; also called extended button press, extended push, and long button press.

Cane – Also referred to as a "long" cane or white cane, usually white or white with a red tip. A primary mobility aid, prescribed by an O&M specialist, which offers protection (from the waist down) and information about the walking surface. Also identifies the pedestrian as being blind or visually impaired.

Channelization – Usually found at intersections with complex geometry. A dedicated lane (either curbed or painted) provided at an intersection to aid the flow of vehicles turning right or left. This channelized lane may be uncontrolled, stop or yield controlled, or signalized.

Controller unit – That part of a controller assembly that is devoted to the selection and timing of the display of signal indications. (MUTCD). This is a computer at the intersection that controls the traffic and pedestrian signals.

Crosswalk - (a) That part of a roadway at an intersection included within the connections of the lateral lines of the sidewalks on opposite sides of the highway measured from the curbs or in the absence of curbs, from the edges of the traversable roadway, and in the absence of a sidewalk on one side of the roadway, the part of a roadway included within the extension of the lateral lines of the sidewalk at right angles to the centerline; (b) any portion of a roadway at an intersection or elsewhere distinctly indicated for pedestrian crossing by lines or other markings on the surface. (MUTCD)

Crosswalk map – A raised schematic map on a pushbutton APS device that shows what will be encountered as the pedestrian negotiates the crosswalk controlled by that push button.

Crosswalk lines – White pavement-marking lines that identify a crosswalk (MUTCD).

Curb radius – The radius of the edge of the pavement. Used to describe the sharpness of a corner. A large curb radius, which enables vehicles to go around corners faster, and gives long vehicles room to turn, results in a slowly curving curb line and curb ramps that are often angled toward the center of the intersection. In addition, the length of the crosswalk is increased. A small curb radius requires vehicles to turn more slowly.

Cycle length – Also referred to as cycle. The time required for one complete sequence of signal indications. (MUTCD) The cycle length includes the entire sequence of green, yellow, and red signal indications for each street at the intersection. For example, the time from one onset of vehicular green for East/West traffic until the onset of the next vehicular green for East/West traffic.

Dark mode – The lack of all signal indications at a signalized location. (MUTCD) The dark mode is most commonly associated with power failures.

Detectable warning – A standardized surface built in or applied to walking surfaces or other elements to warn visually impaired people of hazards in the travel path.(ADAAG) Detectable warning is specified by the ADA as a truncated dome surface. Detectable warnings are used at the edge of transit platforms, curb ramps, and pedestrian refuge islands.

Detector – A sensing device used for determining the presence or passage of vehicles or pedestrians. (MUTCD) When pedestrians and vehicles approach the intersection, the detector recognizes their presence and informs the signal controller.

Dog guide – A trained dog that serves as a primary mobility aid, operating under the direction of an individual with a visual impairment.

DOJ – U.S. Department of Justice; has rulemaking authority and enforcement of ADA.

DOT – U.S. Department of Transportation; implements compliance procedures relating to transportation (streets, traffic management). Each state also has a State Department of Transportation (State DOT).

Eight-phase operation – A signal cycle that is made up of eight distinct phases. Different phasing combinations can be developed to make up the eight phases, as part of actuated control.

Extended push – A feature on an APS that may activate additional information after the pushbutton is pressed down for 1-3 seconds. Also called BAT, extended button press, and long button press.

FHWA - Federal Highway Administration; FHWA Office of Civil Rights oversees the U.S. DOT mandates for accessibility.

Fixed-time operation – See pre-timed operation.

Flashing (flashing mode) – A mode of operation in which a traffic signal indication is turned on and off repetitively. (MUTCD)

Four-phase operation – A signal cycle that is made up of 4 distinct phases. Providing an exclusive left-turn phase for both streets can create a four-phase operation. For example, the 4 phases might be (1) left turns for N-S bound traffic, (2) through N-S bound traffic, (3) left turns for E-W bound traffic, and (4) through E-W bound traffic. The order of the phases varies, depending upon whether the left turning traffic goes before or after the straight through traffic.

Full-actuated operation – A type of traffic control signal operation in which all signal phases function on the basis of actuation. (MUTCD) Thus, the controller reacts to the detection of vehicles and pedestrians, changing the signals as needed to provide maximum efficiency in traffic movements.

Green interval – The time during a signal cycle when vehicles have a green ball (light) indication.

Handler – A person who is blind or visually impaired that uses a dog guide.

Inductive loops – A type of vehicle detector. These loops are typically formed by 12-guage or 14-guage wire placed in slots cut in the pavement. Once a vehicle has passed over or stopped on the wire, a change in the low current electrical flow communicates the presence of the vehicle to the controller unit.

Infrared detection – A type of vehicle or pedestrian detector. Infrared laser beams are sent to the pavement and reflected back. Vehicle presence and speed are determined by the time each beam is entered.

Interval – The part of a signal cycle during which signal indications do not change. (MUTCD) From the pedestrian's perspective the cycle contains three intervals (Walk, flashing Don't Walk and steady Don't Walk).

Interval sequence – The order of appearance of signal indications during successive intervals of a signal cycle. (MUTCD) For example, a green interval followed by a yellow interval followed by a red interval.

Island – A defined area between traffic lanes for control of vehicular movements and for pedestrian refuge. Within an intersection area, a median or an outer separation is considered to be an island. (MUTCD). Islands are usually raised slabs of concrete but can be areas that are just painted.

ITE - Institute of Transportation Engineers, professional membership organization.

Intelligent Transportation System (ITS) technologies – Technologies currently used in a variety of applications for automated detection, counting and classification of vehicles and pedestrians.

Leading Pedestrian Interval (LPI): A pedestrian WALK phase that begins before the green interval serving parallel traffic, rather than at the same time. Thus, pedestrians receive a WALK indication and can begin crossing a few seconds before vehicles in the street parallel to their direction of travel receive vehicular green

Leg – Another term for approach.

Legal blindness – A level of visual impairment that has been defined by law to determine eligibility for benefits and services. Defined as central visual acuity of 20/200 or less in the better eye with best possible correction or a visual field of 20 degrees or less.

Locator tone – A repeating sound that informs approaching pedestrians that they are required to push a button to actuate pedestrian timing. This enables pedestrians who have visual disabilities to locate the pushbutton. Also referred to as locator signal or pushbutton locator tone.

Long button press – A feature on an APS that may activate additional information after the pushbutton is pressed and held down for 1-3 seconds. Also called BAT, extended button press, and extended push feature.

Magnetic detectors – Type of vehicle or pedestrian detection. A device imbedded in the pavement that functions similar to the inductive loops by using the earth's magnetic forces for detection.

Major street – The street normally carrying the higher volume of vehicular traffic. (MUTCD)

Median refuge - An area within an island or median that is intended for pedestrians to wait safely for an opportunity to continue crossing.

Microwave detectors – Type of vehicle or pedestrian detector. A sensor-mounted overhead that uses microwave beams aimed toward the roadways for detecting the presence of vehicles.

Minor street- The street normally carrying the lower volume of vehicular traffic. (MUTCD)

Mobility – The act of movement within the physical environment.

Mobility aid/device – A device, which assists with safety, movement, and information gathering for pedestrians with disabilities.

Multi-phase operation – A traffic signal operating on more than two phases.

MUTCD - *Manual on Uniform Traffic Control Devices*; published by Federal Highway Administration; determines what traffic control devices are required, recommended, or permitted.

NCHRP - National Cooperative Highway Research Program; administered by the Transportation Research board, with funds allocated according to priorities of state highway transportation officials.

NCUTCD - National Committee on Uniform Traffic Control Devices; committee of transportation professionals that makes recommendations to the Federal Highway Administration regarding the MUTCD.

NFB – National Federation of the Blind, membership organization of people who are blind or visually impaired.

NPRM – Notice of Proposed Rulemaking, published in *The Federal Register*. This is one step, usually intended to solicit public comments, in the development of federal regulations such as the ADA guidelines.

Orientation – A process involved in monitoring one's position in space in relation to known landmarks. Persons with visual disabilities stay oriented by using sensory information (traffic sounds, sun, tactual landmarks), and cognition (compass directions, memory, sequencing).

Orientation & Mobility (O&M) – Individualized success-based sequence of instruction used to promote independent travel of persons who are blind or visually impaired.

Orientation & Mobility specialist – A university-trained person who teaches O&M to persons with visual impairments. O&M professionals who are trained by an agency or who do not have a degree from a university are sometimes referred to as O&M instructors.

Parallel street – The street that runs beside, or parallel to a pedestrian's direction of travel.

Parallel surge – When vehicles on the parallel street start moving through the intersection at the onset of the vehicular green signal. The sound of the vehicles starting to move straight ahead is one of the primary cues used by pedestrians who are blind to determine the onset of the Walk interval.

Passive pedestrian detection – A feature that uses sensors (piezo-electric, infrared, microwave or video) to call or cancel the Walk interval; can also be used to extend the pedestrian clearance time.

Ped call – A request to the traffic signal controller for a pedestrian timing, initiated by a pedestrian pushing a pedestrian detector (pushbutton), or by passive pedestrian detection.

Pedestrian – A person afoot or in a wheelchair or scooter.

Pedestrian change interval – An interval during which the flashing UPRAISED HAND (symbolizing DON'T WALK) signal indication is displayed. When a verbal message is provided at an accessible pedestrian signal, the verbal message is "wait." (MUTCD)

Pedestrian clearance time – The time provided for a pedestrian crossing in a crosswalk, after leaving the curb or shoulder, to travel to the center of the farthest traveled lane or to a median. (MUTCD) Typically calculated for a walking speed of 4 feet per second, and typically indicated by a flashing upraised hand.

Pedestrian phase – The time provided for a pedestrian to initiate and complete crossing in a crosswalk. The pedestrian phase includes the Walk interval and the pedestrian change interval, when the flashing upright hand is displayed.

Pedestrian signal head (Pedhead) – A signal head, which contains the symbols WALKING PERSON (symbolizing WALK) and UPRAISED HAND (symbolizing DON'T WALK) that is installed to direct pedestrian traffic at a traffic control signal. (MUTCD)

Permissive mode – A mode of traffic control signal operation in which, when a CIRCULAR GREEN signal indication is displayed, left or right turns may be made after yielding to pedestrians and/or oncoming traffic. (MUTCD)

Perpendicular street - The street one is facing, intending to cross.

Phase – The right-of-way, yellow change, and red clearance intervals in a cycle that are assigned to an independent traffic movement or combination of movements. (MUTCD).

Piezo-electric – Type of pedestrian detection. Paving slabs, which consist of weight sensitive rubber cover a piezo cable located in the curbside area. The weight of the object on the paving slab sends an electric signal through the piezo cable confirming detection.

Platoon – A group of vehicles or pedestrians traveling together as a group, either voluntarily or involuntarily, because of traffic signal controls, geometries, or other factors. (MUTCD).

Pre-timed operation (Fixed-time) – A type of traffic control signal operation in which none of the signal phases function on the basis of actuation. (MUTCD). Thus, each roadway has a predetermined time for a green signal and each crosswalk has a predetermined time for the pedestrian phase. This time remains constant except the phases may be set for different lengths of times for different times of the day.

Prioritization scheme – A system for handling APS requests, evaluating intersections for the need for an APS, and determining locations for APS retrofits.

Professional Traffic Operation Engineer (PTOE) – A licensed professional engineer who holds specialized expertise and certification in traffic operations.

Protected mode – A mode of traffic control signal operation in which left or right turns may be made when a left or right GREEN ARROW signal indication is displayed. (MUTCD) For example, the turning traffic has the right of way when the green arrow is lit.

PROWAAC – Public Rights-of-Way Access Advisory Committee. A committee formed by the Access Board in October 1999 to develop recommendations for guidelines for applying ADA to public rights-of-way.

Public Rights-of-Way (PROW). PROW refers to public sidewalks and roadways designed for pedestrian and vehicular travel. Pedestrians walk, roll, and bicycle in the public rights-of-way. Transit, commercial, and private vehicles drive and park in the PROW. PROW houses hardware, such as traffic signals and streetlights and may contain public and private utilities.

Pushbutton – A button to activate pedestrian timing. (MUTCD) Also known as a pedestrian detector.

Pushbutton actuation Indicators, such as a light, a tone, a voice message, or both audible and visual cue, that signify to pedestrians that the pushbutton has been pressed.

Pushbutton information message – A speech message, which may provide additional intersection information, when the pedestrian pushes the pushbutton on a pushbutton-integrated APS. An extended button press may be required to activate the message.

Pushbutton locator tone– A repeating sound that informs approaching pedestrians that they are required to push a button to actuate pedestrian timing and that enables pedestrians who have visual disabilities to locate the pushbutton. (MUTCD)

Red clearance interval – An optional interval that follows a yellow change interval and precedes the next conflicting green interval. (MUTCD) All approaches have a circular red signal during this very short interval. It is sometimes referred to as “all-red interval”.

Remote activation – A handheld remote feature that allows the pedestrian to send a message over a short distance to the controller to call the pedestrian phase.

Rest in WALK – The pedestrian signal head for crossing a minor street displays WALK and remains on WALK until a conflicting signal phase is called.

Retrofit – Adding an APS device to an existing signalized intersection.

Right/left turn slip lane: A dedicated lane provided at an intersection for the free flow of vehicles turning right or left; may be uncontrolled or stop or yield controlled.

Right-of-Way – The permitting of vehicles and/or pedestrians to proceed in a lawful manner in preference to other vehicles or pedestrians by the display of signal indications. (MUTCD)

Roadway –Public right-of-way dedicated to vehicular traffic.

Scramble crossing – Another term for exclusive pedestrian phasing.

Semi-actuated operation – A type of traffic control signal operation in which at least one, but not all, signal phases function on the basis of actuation. (MUTCD)

Sighted guide or human guide – A technique in which a sighted person leads a person with a visual impairment. There are specific techniques for negotiating narrow spaces, stairs, curbs, closed doors, and other situations.

Signal face – The front part of a signal head. (MUTCD)

Signal head – An assembly of one or more signal faces together with the associated signal housings. (MUTCD) There are signal heads for vehicles (display traffic signals) and pedestrians (display Walk and Don' t Walk signals).

Signal indication – The illumination of a signal lens or equivalent device. (MUTCD) For example, the circular green is a type of signal indication.

Signal phase – The right-of-way, yellow change, and red clearance intervals in a cycle that are assigned to an independent traffic movement or combination of movements. (MUTCD) Each movement within the cycle is referred to as a signal phase.

Signal technician – A person who works under the direction of traffic engineers. Installing APS hardware may be one responsibility of a signal technician.

Signal timing – The amount of time allocated for the display of a signal indication. (MUTCD)

Signal warrant – A threshold condition that, if found to be satisfied as part of an engineering study, shall result in analysis of other traffic conditions or factors to determine whether a traffic control signal or other improvement is justified. (MUTCD)

Steady (steady mode) – The continuous illumination of a signal indication for the duration of an interval, signal phase, or consecutive signal phases. (MUTCD)

Tactile – Using the sense of touch to perceive an object.

Tactile arrow – A raised arrow on an APS that helps pedestrians know which crosswalk is actuated by the pushbutton.

Tactile map – A raised schematic map that shows what will be encountered as the pedestrian negotiates the crosswalk controlled by that push button. This is the same as crosswalk map.

TEA-21 – Transportation Equity Act for the 21st Century; makes available federal funds for pedestrian improvements, including APS installations.

Three-phase operation – Adds a left-protection (phase) to the two-phase operation. For example, the phases would be (1) through traffic on N-S street, (2) through traffic on E-W street and (3) protected left turning traffic. The left turn phase can be before (lead left) or after (lag left) the through traffic.

Through movements - Vehicular or pedestrian traffic permitted to proceed straight through the intersection (without turning) during the designated signal phase.

TITLE II - The title of the Americans with Disabilities Act that is applicable to state and local government properties and facilities, i.e., most intersections.

Traffic control signal (traffic signal) – Any highway traffic signal by which traffic is alternately directed to stop and permitted to proceed. (MUTCD)

Traffic engineer –Professional engineer who works in traffic operations. One of the primary roles of traffic engineers is to conduct field studies and to make decisions regarding signalization and other factors influencing traffic conditions.

Travel instructor – University trained professional who teaches community travel skills to persons with disabilities other than blindness or visual impairment.

Travel trainer – A person who teaches some, but not all, travel skills to persons with disabilities other than blindness or visual impairment. Travel trainers work under the direction of Travel Instructors.

TRB – Transportation Research Board; part of National Academy of Sciences; makes available funds for research in transportation areas. Many key decisions related to signalization are made from this research.

Two-phase operation – Each street at a signalized intersection receives one phase during which all movements, including pedestrian movements, are made.

Turn phasing – A phase involving a turn movement only.

UFAS- Uniform Federal Accessibility Standard. 1984.

Ultrasonic detection– Type of vehicle detection. Device sends ultrasonic waves to the pavement from an overhead mounted location. When a vehicle is in the detection zone, the ultrasonic wave is reflected off the vehicle and back to the controller device.

Veering – Walking in a path of travel that differs from one's intended line of direction. Veering during a street crossing means the pedestrian walks outside the crosswalk area, either toward or away from the parallel street. Veering is a problem for some pedestrians who are blind.

Vibrotactile pedestrian device – A device that communicates, by touch, information about pedestrian timing using a vibrating surface. (MUTCD) The pushbutton vibrates when the WALK signal is lit.

Video detection – Type of vehicle or pedestrian detection. A wide-area video image of the detection zone is captured from an overhead camera. Vehicles are detected as the light intensity of the image on the pictals changes in the detector zones. Once the vehicle is detected a message is sent to the traffic controller unit.

WALK interval – An interval during which the WALKING PERSON (symbolizing WALK) signal indication is displayed. When a verbal message is provided at an accessible pedestrian signal, the verbal message is "walk sign". (MUTCD) This interval is the time when pedestrians should leave the curb and start crossing the street

Yellow change interval – The first interval following the green interval during which the yellow signal indication is displayed. (MUTCD)

ORGANIZATIONS

Consumer Groups

ACB – American Council of the Blind
1155 15th Street, NW Suite 1004
Washington, D.C. 20005
Phone:(202) 467-5081 or (800)424-8666
Fax: (202) 467-5085
Website: www.acb.org

NFB – National Federation of the Blind
1800 Johnson Street
Baltimore, MD 21230
Phone:(410) 659-9314
Email: nfb@nfb.org
Website: www.nfb.org

Government Agencies

ATBCB - U.S. Architectural and Transportation Barriers Compliance Board (Also called Access Board)
1331 F Street, NW
Suite 1000
Washington, D.C. 20004-1111
Phone:(202) 272-5434 TTY: 202-272-5449
Fax: (202) 272-5447
Email: info@access-board.gov
Website: www.access-board.gov

FHWA – Federal Highway Administration
400 7th Street, SW
Washington, D.C. 20590
Website: www.fhwa.dot.gov

Professional Membership Organizations

ACVREP – Academy for Certification of Vision Rehabilitation and Education Professionals
P.O. Box 91047
Tucson, AZ 85752-1047
Voice:(520) 887-6816
Fax: (520) 887-6826
Email: info@acvrep.org
Website: www.acvrep.org

AER – Association for Education & Rehabilitation of the Blind & Visually Impaired
4600 Duke Street, Suite 430
P.O. Box 22397
Alexandria, VA 22304
Phone:(703) 823-9690 or (877) 492-2708
Fax: (703) 823-9695
Email: aer@aerbvi.org
Website: www.aerbvi.org

APBP – Association of Pedestrian & Bicycle Professionals
P.O. Box 23576
Washington, D.C. 26026
Phone:(202) 366-4071
Fax: (703) 876-0562
Email: pedbike@aol.com
Website: www.apbp.org

AASHTO – American Association of State Highway & Transportation Officials
444 North Capitol Street, NW, Suite 225
Washington, D.C. 20001
Phone:(888) 227-4860
Website: www.aashto.org

ATI – Association of Travel Instruction
Box 2042
Madison Square Garden
New York, NY 10159
Phone:(718) 803-3782, ext 278
Fax: (718) 803-1252

ITE – Institute of Transportation Engineers
1099 14th St., N.W. Suite 300 West
Washington, D.C. 20418
Phone:(202) 289-0222
Fax: (202) 289-7722
Website: www.ite.org

TRB – Transportation Research Board
500 Fifth Street, NW
Washington, D.C. 20001
Phone:(202) 334-2934
Fax: (202) 334-2003
Website: www.trg.org

APS Manufacturer Information

Campbell Company
211 West 37th Street, Suite C
Boise, Idaho 83706
Phone: (877) 345-1727, (208) 345-7459
Fax: (208) 345-7481
Website: www.pedsafety.com

Georgetown Electric, Ltd.
2507 West Second Street
Wilmington, DE 19805
Phone: (302) 652-4835
Fax: (302) 652-6447
E-Mail: vipb98@aol.com

Mallory Sonalert Products, Inc.
7545 Rockville Road
Indianapolis, IN 46214
Phone: (317) 273-0090
Fax: (317) 273-2400
Website: www.mallory-sonalert.com

Novax Industries, Inc
658 Derwent Way
New Westminister, BC V3M5P8 Canada
Phone: (604) 525-5644
Fax: (604) 525-2739
Website: www.novax.com

Panich Consultancy Pty. Ltd.
P.O. Box 360
Ryde, NSW 2112, Australia
48 Church Street
Ryde NSW 2112, Australia
Phone: 61 2 9809 6499
Fax: 61 2 9809 6962
Website: www.bobpanich.com.au

Panich U.S. distributor
Summers Distributing, Gary Summers
8902 Red River Ct.
Bakersfield, CA 93312 USA
Phone: (661) 587-7214
fax: (661) 587-7109
E-mail: accessallpeds@hotmail.com

Polara Engineering
4115 Artesia Avenue
Fullerton , CA 92833-2520
Phone: (888) 340-4872
Phone: (714) 521-0900
Fax: (714) 522-8001
Website: www.polara.com

Prisma Teknik AB
P.O. Box 5, S-543 21, Tibro, Sweden
Phone: (46) 504 150 40
Fax: (46) 504 141 41
Website: www.prismateknik.com

Prisma Teknik U.S. distributor
Eagle Traffic Control Systems
8004 Cameron Road, Austin, TX 78754
Phone: (512) 837-8310
Fax: (512) 837-0196
E-Mail: info@eaglets.com

Relume Corporation
64 Park Street, Troy, MI 48083
Phone: 888-7RELUME, (248) 585-2640
Fax: (248) 585-1909
Website: www.relume.com

Talking Signs Inc.
812 North Blvd., Baton Rouge, LA 70802
Phone: (888) 825-5746
Fax: (504) 344-2811
Website: www.talkingsigns.com

U.S. Traffic Corporation
9603 John Street
Santa Fe Springs, CA 90670
Phone: (562) 923-9600, (800) 733-7872
Fax: (562) 923-7555
Website: www.ustraffic.net

Wilcox Sales Company
1738 Finecroft Drive
Claremont, CA 91711-2411
Phone:(909) 624-6674
Fax: (909) 624-8207
Website: www.wilcoxsales.com

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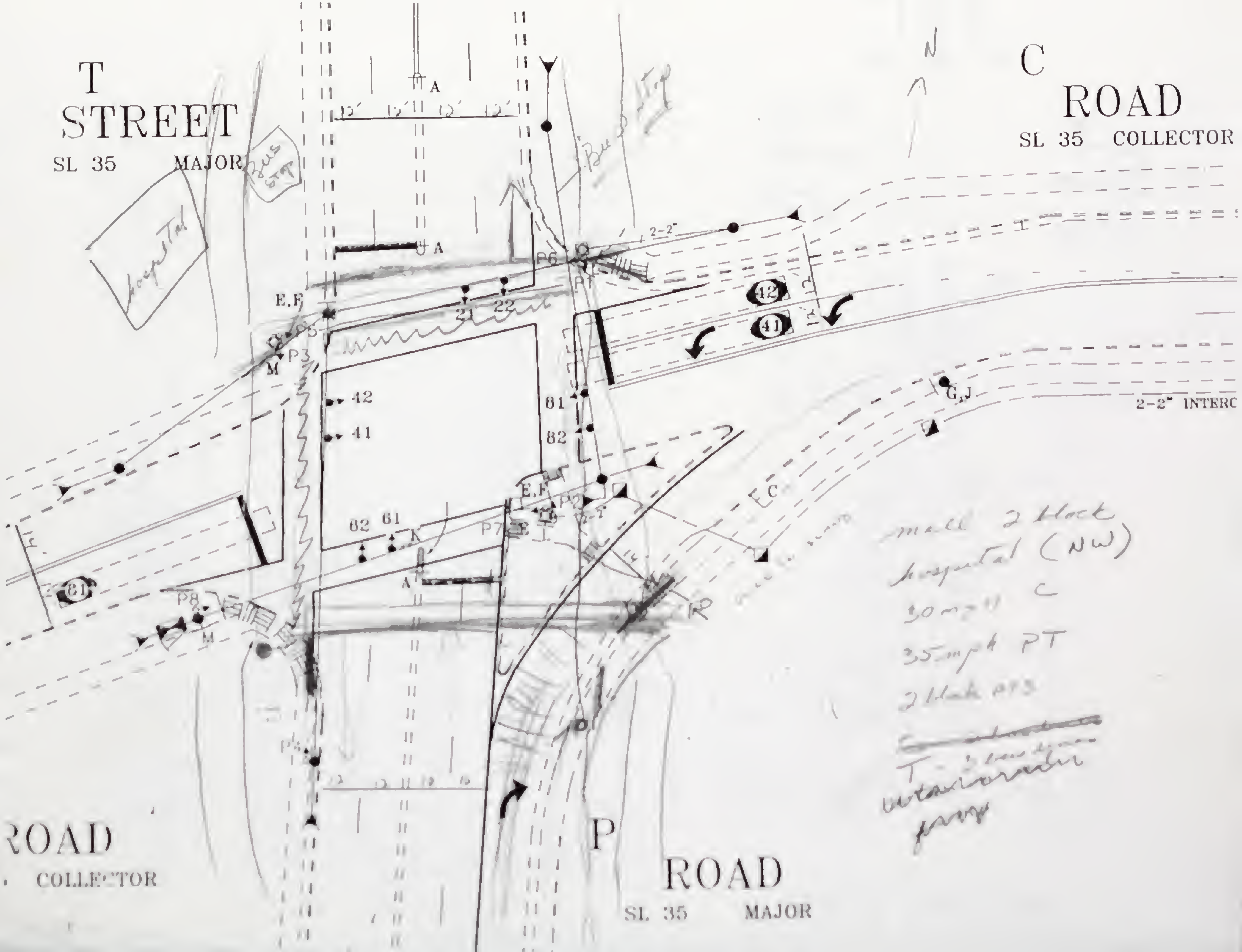


mall 2 block
hospital (NW)
30 mph C
35 mph PT
2 block PTS

T - 2 lane [illegible]
uncontrolled
ramp

SIGNAL SEQUENCE

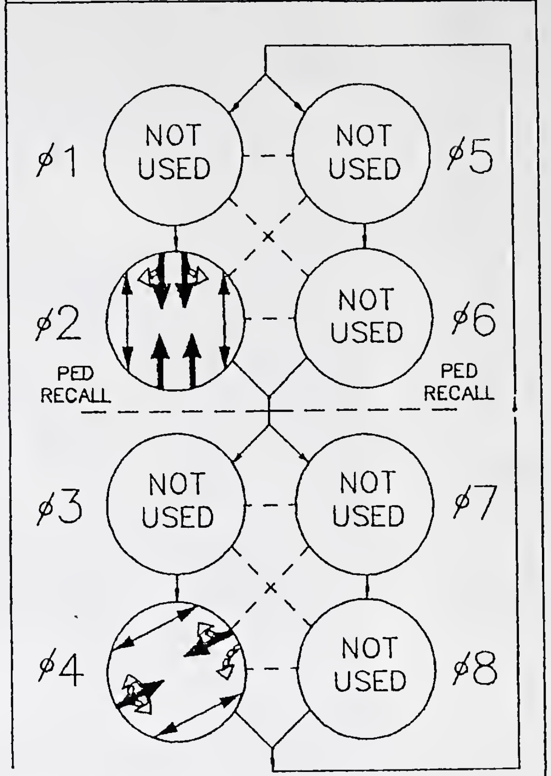
RING 1	PHASE 1			PHASE 2			PHASE 3			PHASE 4			FLASH
SIGNAL ID NUMBER	R/W	CLEAR TO O T H		R/W	CLEAR TO O T H		R/W	CLEAR TO O T H		R/W	CLEAR TO O T H		
21,22,61,62				G	Y								Y
41,42,81,82										G	Y		R
P1,P2,P3,P4				W/FDW	DW								DARK
P5,P6,P7,P8										W/FDW	DW		DARK

RING 2	PHASE 5			PHASE 6			PHASE 7			PHASE 8			FLASH
SIGNAL ID NUMBER	R/W	CLEAR TO O T H		R/W	CLEAR TO O T H		R/W	CLEAR TO O T H		R/W	CLEAR TO O T H		

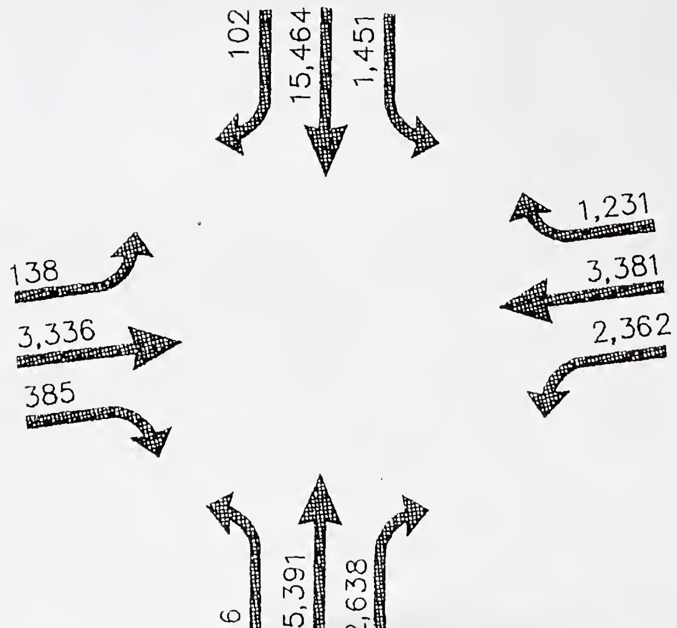
OVERLAP/PHASES	OL-A/ +				OL-B/ +				OL-C/ +				OL-D/ +				FLASH
SIGNAL ID NUMBER	CLEAR TO			O T H	CLEAR TO			O T H	CLEAR TO			O T H	CLEAR TO			O T H	

◀ RED ARROW ◁ YELLOW ARROW ◀ GREEN ARROW

PHASE DIAGRAM



24 HOUR TRAFFIC VOLUMES



Prioritization scheme
#3

Attachment B

AUDIBLE PEDESTRIAN SIGNAL EVALUATION FACTORS

City of Portland, Oregon

May 2000

The following factors shall be used to prioritize potential audible pedestrian signal (APS) locations. An evaluation team comprised of city staff and a mobility specialist will conduct the scoring of factors. The person making the request will be consulted during the course of the evaluation to better determine the pedestrian's needs.

A. *PEDESTRIAN USAGE*

1. Proximity to facilities for the elderly and/or disabled: This includes, but is not limited to, the Oregon Commission for the Blind, Vision NW, Independent Living Resources, and senior retirement complexes. Points are assigned on the basis of blocks (1 block equals 200 feet) from proposed audible signal site to subject facility. The closer the two are, the more points are given.

Proximity	Points
4 – 6 blocks	2
3 blocks	4
2 blocks	6
1 block	8
less than 1 block	[✓ 10]

2. Proximity to key destinations: This includes, but is not limited to, medical, educational, social, recreational, commercial, and public facilities. Points are assigned on the basis of blocks (1 block equals 200 feet) from the proposed audible signal site to subject facility. The closer the two are, the more points are given. In case of multiple facilities, points will be given on the basis of the closest facility.

Proximity	Points
4 – 6 blocks	2
3 blocks	4

#3

2 blocks	[✓ 6]
1 block	8
less than 1 block	~~[✓ 10]~~

3. Proximity to transit stops/routes: Because many visually impaired people rely on public transportation, points will be given for the number of transit stops and/or routes within one block of the proposed audible signal site.

Number of routes and stops	Points
1 – 2 routes and 1 stop	4
1 – 2 routes and 2 stops	6
3 or more routes and 3+ stops	[✓ 8]

4. Need to cross: The more frequent the usage of the audible signal, the more points are given. This information must be provided by the requestor.

Need	Points
Occasionally (approximately 1x per week)	2
Regularly (approximately 3x per week)	4
Daily	[✓ 6]
High (justify below)	8

5. Alternate crossing location: The presence of a good installing an audible signal. The further away a good crossing location is from the proposed audible signal site, the more points are given.

Proximity	Points
Good crossing within 400 feet	[✓ 1]
Good crossing within 401 – 600 feet	2
Good crossing within 601 – 800 feet	3
Good crossing within 1000 feet	4

#3

6 Pedestrian accidents in past 4 years: Past pedestrian accident experience at the intersection will be used as an indicator of potential safety. Based on reported accident information, the higher the occurrence of accidents the higher number of points given

Pedestrian Accidents	Points
1	[✓ 2]
2	4
3	6
4	8
5	10

B INTERSECTION CONDITIONS

1 Intersection Configuration: The number of approaches to an intersection and their geometric configuration (offset, skewed, etc.) affect the ease or difficulty of crossing for the visually impaired. In particular, traffic at 3-leg intersections tends not to provide adequate audible clues for the visually impaired to permit them to effectively judge the signal phases.

Configuration	Points
4 leg right angle intersection	1
3 leg tee intersection	2
3 or 4 leg skewed intersection	3
4 leg offset intersection	4
Other complex or unusual intersection	[✓ 5]

2 Width of crossing: Wider streets present more crossing difficulties for those who are visually impaired. If each leg of the intersection has a different width, the widest street measurement will be used. Crossing width will be measured at the point pedestrians normally cross the street. The wider the crossing, the more points will be given.

Width of crossing	Points
40 feet or less	1
41 – 52 feet	2
52 – 68 feet	[✓ 3]
69 – 78 feet	4
79 + feet	5

#3

3. Traffic Volume: Traffic volume may impede or assist visually impaired pedestrians. Optimal crossing conditions occur when crossing right angle signalized intersections with a moderate but steady flow of traffic through the intersection on each leg with a minimum of turning movements. Traffic that is either light, very heavy, or erratic in its flow makes it difficult to pick up audible clues as to whether the light is red or green. In such cases, audible signals can assist in determining when it is possible to safely cross the street. Traffic volume will be separated into different classifications, and points will be given per each classification.

A. Heavy traffic flow: Approach traffic on all legs is in excess of 2000 vehicles per hour during any peak hour.

Vehicles per hour	Points
2000 – 2999	1
3000 – 3999	[✓ 2]
4000 – 4999	3
5000 – 5999	4
6000 +	5

B. Light traffic flow: Approach traffic on all legs is less than 900 vehicles per hour during any one hour period between 6 AM and 6 PM

Vehicles per hour	Points
800 – 899	1
700 – 799	2
600 – 699	3
500 – 599	[✓ 4]
under 500	5

C. MOBILITY EVALUATION

1. Based upon evaluation by city staff and mobility instructor. 0 – 10 points may be assigned based on the following comments:

Additional points may be assigned for unique circumstances as described below:

#3

Attachment C
APS SUMMARY EVALUATION FORM
City of Portland

LOCATION: ______________________

PED LANES: ______________________

DATE: ______________________

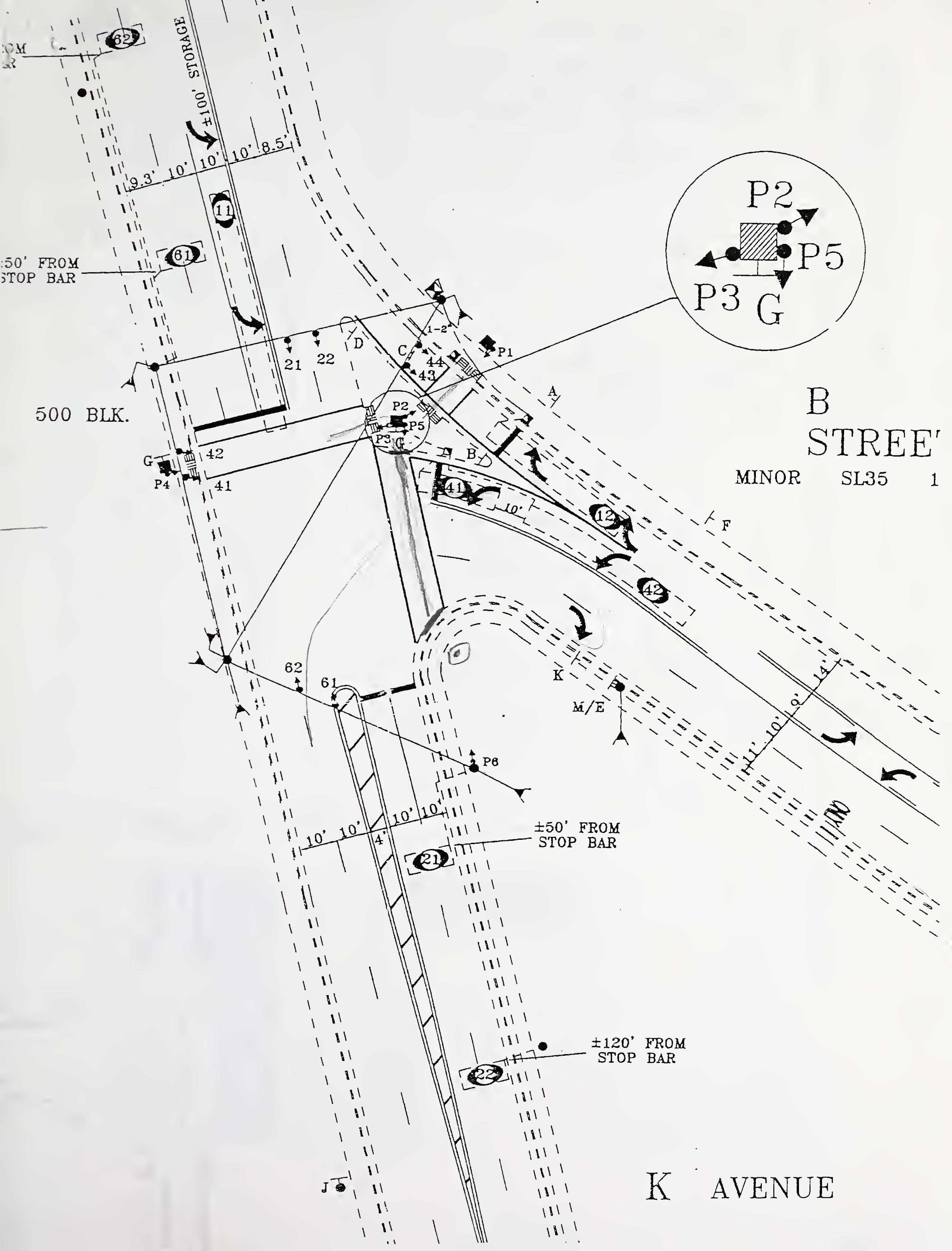
CRITERIA:		POINTS:		
A. Pedestrian Usage				
1. Proximity to facilities for the visually impaired		10	– 10	
2. Proximity to key destinations	16	6	– 10	
3. Proximity to transit stops/routes	24	8	– 8	28
4. Need to cross	30	6	– 6	34
5. Alternate crossing location	31	1	– 1	35
6. Pedestrian accidents last 4 years	33	2	– 2	37
B. Intersection Conditions				
1. Configuration	38	5	– 5	42
2. Width	41	3	– 3	45
3. Volume	47	6	– 6	51
C. Mobility Evaluation				
1. Mobility and miscellaneous factors	57	10		10

Comments:

____

____

TOTAL POINTS: 57 61


±100' STORAGE
9.3'
10'
10'
10'
8.5'
11
62
61
±50' FROM
STOP BAR
500 BLK.
21
22
D
C
1-2
44
43
P1
P2
P5
P3
G
A
B
42
41
G
P4
10'
12
F
B
STREET
MINOR SL35 1
42
K
M/E
62
61
P6
10'
10'
4'
10'
10'
±50' FROM
STOP BAR
21
11'
10'
9'
14'
±120' FROM
STOP BAR
22
J
K AVENUE

SIGNAL SEQUENCE

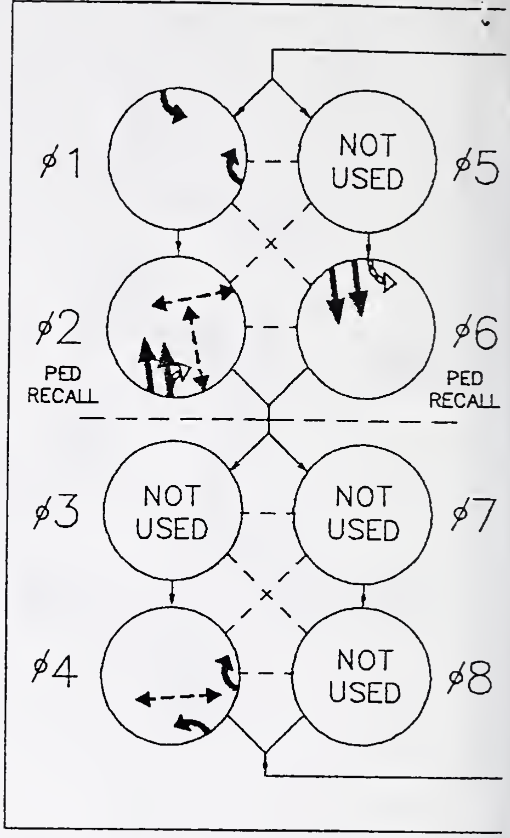
RING 1	PHASE 1			PHASE 2			PHASE 3			PHASE 4			FLASH
SIGNAL ID NUMBER	R/W	CLEAR TO OTH		R/W	CLEAR TO OTH		R/W	CLEAR TO OTH		R/W	CLEAR TO OTH		
21,22				G	Y								Y
41,42										G	Y		R
61a	◀	◁											—
P1,P2				W/FDW	DW								DARK
P3,P4										W/FDW	DW		DARK
P5,P6				W/FDW	DW								DARK

RING 2	PHASE 5			PHASE 6			PHASE 7			PHASE 8			FLASH
SIGNAL ID NUMBER	R/W	CLEAR TO OTH		R/W	CLEAR TO OTH		R/W	CLEAR TO OTH		R/W	CLEAR TO OTH		
61,62				G	Y								Y

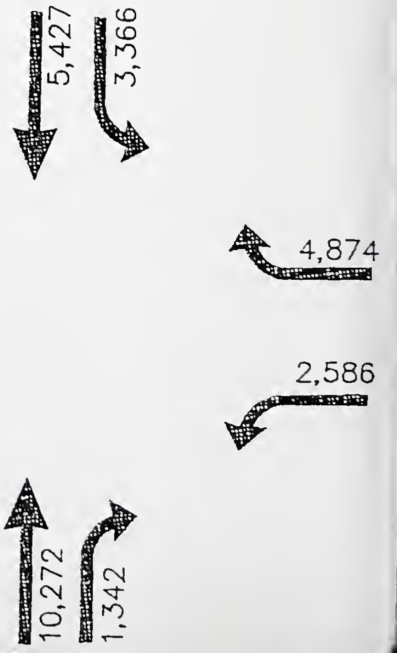
OVERLAP/PHASES	OL-A/1+4				OL-B/ +				OL-C/ +				OL-D/ +				FLASH
SIGNAL ID NUMBER	CLEAR TO				CLEAR TO				CLEAR TO				CLEAR TO				
	1	4	OTH					OTH				OTH				OTH	
43,44	▶	▶	▷														⯈

⯇ RED ARROW ◁ YELLOW ARROW ◀ GREEN A

PHASE DIAGRAM



24 HOUR TRAFFIC VOLUMES



Prioritization Scheme #1

DRAFT - *Mar 13, 2001*

WORKSHEET FOR EVALUATING THE INSTALLATION OF ACCESSIBLE PEDESTRIAN SIGNALS (APS)

Date:

Location:

FACTOR	**Sub-FACTOR**	**Applicable condition** (select one condition within each sub-factor)	Points
Intersection Safety			
	Intersection Configuration		
		4 - leg	2
		4 - leg skewed	4
		4 - leg offset	6
		3 - leg, crossing main street	8
		mid-block signal, 5-leg, or unusual geom.	10

LEG			
North	South	East	West

FACTOR	**Sub-FACTOR**	**Applicable condition**	Points
	Number of pedestrian accidents (Source: MSHA statistics)		
		< than statewide average	0
		> than statewide average	2

Width of Crossing						
	< 50'	2				
	51' - 75'	5				
	76' - 95'	7				
	> 96'	10				
Traffic signal Phasing						
	2 phase	2				
	split phasing	6				
	Right turn signal	8				
	Double Right Turn	8				
	continuous RTOR permitted	10				
	wide median/ped. crosses 1/2 ea. phase	10				
Traffic Volumes						
	0 vehicles on cross st./any 5 min period	15				
	average < 1 vehicles per cycle	10				
	1 vehicle queue per cycle	8				
	2 vehicle queue per cycle	4				
	> 2 vehicle queue per cycle	0				
Vehicle Speed (operating)						
	0 - 30 mph	1				
	31 -45	3				
	> 45 mph	5				

#1

Pedestrian Usage

Proximity to facility used by all Peds

> 6 blocks	0
3 - 5 blocks	2
1 - 2 blocks	4
At facility	6

Access to Transit Routes and Stops

single stop and single route	2
multi stop and/or multi route	6

Transit passengers within one block (per day)

10 to 50	2
51 to 150	4
> 150	6

TOTAL POINTS

OTHER FACTORS (these and others are to be discussed under comments)

Need to Cross

Alternative Crossings available

Free Right Turn (no signal)

Traffic Back up through intersection

Leading Pedestrian Indication (LPI)

High ambient noise

Comments

Orientation & Mobility Specialist:

Traffic Engineer:

Requestor:

Other:

Prioritization Scheme #2

Intersection:

INTERSECTION FEATURES	POINTS	North leg	South leg	East leg	West leg	Other	COMMENTS
1. Configuration of Intersection							Configuration
4 - Leg Skewed Intersection	2						
4 - Leg Offset Intersection (Crossing Minor)	3						
3 - Leg "T" (Crossing Major Street)	4						
4 - Leg Offset (Crossing Major Street)	4						
> 4 Legs/Midblock/Unusual Geometry	5						
2. Width of Street Crossing (at Crosswalk)							Width of Crossing
60 - 79 ft.	2						
80 - 99 ft.	3						
100 - 119 ft.	4						
120+ ft.	5						
3. Speed limit (street being crossed)							Average Vehicle Speed
25 - 30 mph	1						
31 - 35 mph	2						
36 - 40 mph	3						
41+ mph	5						
4. Traffic Volume (non-peak hour queue in through lanes parallel to crossing)							Traffic Volume
<1 vehicle	5						
<2 vehicles	4						
<3 vehicles	3						
<4 vehicles	2						
		North leg	South leg	East leg	West leg	Other	
INTERSECTION FEATURES - page 1 POINT TOTALS							

#2

Intersection:

INTERSECTION FEATURES (continued)	POINTS	North leg	South leg	East leg	West leg	Other	COMMENTS
5. Intersection Signalization							**Intersection signalization**
Pedestrian Actuation Required	4						
Semi-Actuated (Crossing the Major Street)	5						
Split Phase (street parallel to the crosswalk)	2						
Full Vehicular Actuation	5						
Leading Pedestrian Interval	10						
Left Turn Arrow (street parallel to the crosswalk)							
1 Lane	2						
2 Lanes	4						
Right Turn on Red Permitted	1						
Exclusive Pedestrian Phase w/ROR Permitted	10						
Exclusive Ped. Phase w/No ROR Permitted	5						
Signalized right turn lane (pts go in 'other' column)	10						
6. Traffic Conditions							**Traffic Conditions**
Heavy Right Turn Volume during Ped. Phase	8						
(>3 vehicles/phase @ near side)							
Traffic Backed Up Through Intersection	2						
7. Intersection Geometry							**Intersection Geometry**
Right-Turn (splitter) island (pts go in 'other' column	3						
Turn radius (either corner of xwalk) >25 ft	4						
Curbramps Not Aligned with Crosswalk	4						
Median Where Ped Crosses Halfway ea Phase	10						
Pushbutton >10 ft from curb	5						
Pushutton >5 ft from crosswalk extended	5						
Poor Visibility of Pedestrians	4						
Gradient (slope affects hearing surge, veering)	2						
		North leg	South leg	East leg	West leg		
INTERSECTION FEATURES Page 2 POINT TOTALS							

#2

Intersection:

PEDESTRIAN USAGE	POINTS	North leg	South Leg	East leg	West leg	Other	COMMENTS
1. Proximity to Facility for Blind People							**Facility for Blind People**
Within 1600 - 2400 ft.	2						
Within 1200 ft.	4						
Within 800 ft.	6						
Within 400 ft.	8						
Adjacent to Facility	10						
2. Proximity to Alternative Crossing							**Alternative Crossing**
Installed APS within 400 ft.	3						
Installed APS within 800 ft.	4						
No installed APS within 1200 ft.	5						
3. Proximity to Key Facilities for All Pedestrians							**Facilities for All Pedestrians**
> 1600 ft.	1						
Within 1200 ft.	2						
Within 800 ft.	3						
Within 400 ft.	4						
At Facility	5						
4. Proximity to Transit Stops & Routes within 400 ft.							**Transit Stops & Routes**
1 Route	1						
2 Routes	3						
3+ routes	5						
Rail Transit Station Connecting with Bus	10						
Bus Terminal	10						
5. Request for APS							**Request for APS**
Crosses more than 5 times/week	10						
Crosses 1- 5 times/week	8						
Crosses less than once a week	6						
More than one requestor - add, in addition to above	10						
		North leg	South leg	East leg	West leg	Other	
PEDESTRIAN USAGE POINT TOTALS							

Intersection:

OTHER ISSUES (DESCRIBE AND ASSIGN POINTS)	North leg	South leg	East leg	West leg	Other
	North leg	**South leg**	**East leg**	**West leg**	**Other**
OTHER ISSUES POINT TOTALS					

Intersection Location:

Evaluation Date:

Evaluator:

Contact Information (phone, e-mail address):

Referral:

ID legs (for example, North leg is crossing of Main Street) if intersection is skewed, or if there may be question about which one is labeled north

If necessary, sketch intersection

INTERSECTION RATING	North leg	South leg	East leg	West leg	Other, (multi-leg, signalized right turn, etc)
Intersection features, page 1					
Intersection features, page 2					
Pedestrian usage, page 3					
Other Issues, page 4					
	North	South	East	West	Other
TOTAL SCORE, EACH CROSSING					

Appendix A
Module 1
Glossary

AASHTO - American Association of State Highway and Transportation Officials: responsible for publication of "The Green Book". (*A Policy on Geometric Design of Highways & Streets*) which is the premier resource on intersection geometry.

ACB - American Council of the Blind, a membership organization of people who are blind or visually impaired.

Access Board – Short name for the independent federal agency responsible for developing accessibility guidelines under ADA. Also referred to as the U.S. Architectural and Transportation Barriers Compliance Board (ATBCB).

ACVREP – Academy for Certification of Vision Rehabilitation and Education Professionals. A certification body for professionals who work in education and rehabilitation of individuals who are blind or visually impaired.

ADA – Americans with Disabilities Act, Public Law 226. Federal civil rights statute that prohibits discrimination against persons with disabilities. Requires public entities and public accommodations to provide accessible accommodations to persons with disabilities. ADA Draft Guidelines for Public-Rights-of-Way Accessibility Guidelines were issued in June 2002.

ADAAG - Americans with Disabilities Act Accessibility Guidelines. ADA standards for accessible designs for buildings and facilities. Written by the Access Board and adopted and enforced by the DOJ and DOT.

AER - Association for Education and Rehabilitation of the Blind and Visually Impaired, membership organization of professionals who work with persons with visual impairments in education and rehabilitation settings.

ANSI – American National Standards Institute. ANSI A117 provides technical specifications for making buildings and facilities accessible to persons with disabilities.

APBP - Association of Pedestrian and Bicycle Professionals, professional membership organization.

ATBCB - U.S. Architectural and Transportation Barriers Compliance Board. Short name is Access Board.

ATI - Association of Travel Instruction, membership organization for professionals who provide travel instruction to persons with disabilities other than blindness.

FHWA - Federal Highway Administration; FHWA Office of Civil Rights oversees the U.S. DOT mandates for accessibility.

ITE - Institute of Transportation Engineers, professional membership organization.

Intelligent Transportation System (ITS) technologies – Technologies currently used in a variety of applications for automated detection, counting and classification of vehicles and pedestrians.

MUTCD - *Manual on Uniform Traffic Control Devices*; published by Federal Highway Administration; determines what traffic control devices are required, recommended, or permitted.

NCHRP - National Cooperative Highway Research Program; administered by the Transportation Research board, with funds allocated according to priorities of state highway transportation officials.

NCUTCD - National Committee on Uniform Traffic Control Devices; committee of transportation professionals that makes recommendations to the Federal Highway Administration regarding the MUTCD.

NFB – National Federation of the Blind, membership organization of people who are blind or visually impaired.

NPRM – Notice of Proposed Rulemaking, published in *The Federal Register*. This is one step, usually intended to solicit public comments, in the development of federal regulations such as the ADA guidelines.

PROWAAC – Public Rights-of-Way Access Advisory Committee. A committee formed by the Access Board in October 1999 to develop recommendations for guidelines for applying ADA to public rights-of-way.

Public Rights-of-Way (PROW). PROW refers to public sidewalks and roadways designed for pedestrian and vehicular travel. Pedestrians walk, roll, and bicycle in the public rights-of-way. Transit, commercial, and private vehicles drive and park in the PROW. PROW houses hardware, such as traffic signals and streetlights and may contain public and private utilities.

TEA-21 – Transportation Equity Act for the 21st Century; makes available federal funds for pedestrian improvements, including APS installations.

TITLE II - The title of the Americans with Disabilities Act that is applicable to state and local government properties and facilities, i.e., most intersections.

TRB – Transportation Research Board; part of National Academy of Sciences; makes available funds for research in transportation areas. Many key decisions related to signalization are made from this research.

UFAS- Uniform Federal Accessibility Standard,1984.

Appendix C
Module 2B
Glossary

Alignment – Aligning one's body and mentally projecting a straight line across the street toward the destination corner. Pedestrians who are blind use auditory and tactile information to align their bodies for street crossings. Engineers also use the term alignment in talking about roadway alignment.

Cane – Also referred to as a "long" cane or white cane, usually white or white with a red tip. A primary mobility aid, prescribed by an O&M specialist, which offers protection (from the waist down) and information about the walking surface. Also identifies the pedestrian as being blind or visually impaired.

Detectable warning – A standardized surface built in or applied to walking surfaces or other elements to warn visually impaired people of hazards in the travel path.(ADAAG) Detectable warning is specified by the ADA as a truncated dome surface. Detectable warnings are used at the edge of transit platforms, curb ramps, and pedestrian refuge islands.

Dog guide – A trained dog that serves as a primary mobility aid, operating under the direction of an individual with a visual impairment.

DOJ – U.S. Department of Justice; has rulemaking authority and enforcement of ADA.

DOT – U.S. Department of Transportation; implements compliance procedures relating to transportation (streets, traffic management). Each state also has a State Department of Transportation (State DOT).

Handler – A person who is blind or visually impaired that uses a dog guide.

Legal blindness – A level of visual impairment that has been defined by law to determine eligibility for benefits and services. Defined as central visual acuity of 20/200 or less in the better eye with best possible correction or a visual field of 20 degrees or less.

Mobility – The act of movement within the physical environment.

Mobility aid/device – A device, which assists with safety, movement, and information gathering for pedestrians with disabilities.

Orientation – A process involved in monitoring one's position in space in relation to known landmarks. Persons with visual disabilities stay oriented by using sensory information (traffic sounds, sun, tactual landmarks), and cognition (compass directions, memory, sequencing).

Orientation & Mobility (O&M) – Individualized success-based sequence of instruction used to promote independent travel of persons who are blind or visually impaired.

Orientation & Mobility specialist – A university-trained person who teaches O&M to persons with visual impairments. O&M professionals who are trained by an agency or who do not have a degree from a university are sometimes referred to as O&M instructors.

Parallel street – The street that runs beside, or parallel to a pedestrian's direction of travel.

Parallel surge – When vehicles on the parallel street start moving through the intersection at the onset of the vehicular green signal. The sound of the vehicles starting to move straight ahead is one of the primary cues used by pedestrians who are blind to determine the onset of the Walk interval.

Pedestrian – A person afoot or in a wheelchair or scooter.

Perpendicular street - The street one is facing, intending to cross.

Sighted guide or human guide – A technique in which a sighted person leads a person with a visual impairment. There are specific techniques for negotiating narrow spaces, stairs, curbs, closed doors, and other situations.

Tactile – Using the sense of touch to perceive an object.

Travel instructor – University trained professional who teaches community travel skills to persons with disabilities other than blindness or visual impairment.

Travel trainer – A person who teaches some, but not all, travel skills to persons with disabilities other than blindness or visual impairment. Travel trainers work under the direction of Travel Instructors.

Veering – Walking in a path of travel that differs from one's intended line of direction. Veering during a street crossing means the pedestrian walks outside the crosswalk area, either toward or away from the parallel street. Veering is a problem for some pedestrians who are blind.

Appendix B
Module 2A
Glossary

Actuated operation – A type of traffic control signal operation in which some or all signal phases are operated on the basis of actuation. (MUTCD) At actuated intersections, the controller (computer) adjusts the signals to ensure maximum efficiency of traffic movements, based on the volume of vehicles and pedestrians detected at the intersection at that particular time.

Actuation – Initiation of a change in or extension of a traffic signal phase through the operation of any type of detector. (MUTCD). One example would be when several vehicles on a minor street are stopped at a red signal and their presence is detected, the controller will change the signal to green and give the major street a red signal. The length of the green signal on the minor street depends on the number of vehicles on that street.

Approach – All lanes of traffic moving towards an intersection or a mid-block location from one direction, including any adjacent parking lane(s). (MUTCD) Thus, a plus shaped intersection has 4 approaches. A T-shaped intersection has 3 approaches.

Arterial street – A general term denoting a street primarily used by through traffic, usually on a continuous route or highway designated as part of an arterial system. (MUTCD)

Average day – A day representing traffic volumes normally and repeatedly found at a location, typically a weekday when volumes are influenced by employment or a weekend when volumes are influenced by entertainment or recreation. (MUTCD)

Channelization – Usually found at intersections with complex geometry. A dedicated lane (either curbed or painted) provided at an intersection to aid the flow of vehicles turning right or left. This channelized lane may be uncontrolled, stop or yield controlled, or signalized.

Controller unit – That part of a controller assembly that is devoted to the selection and timing of the display of signal indications. (MUTCD). This is a computer at the intersection that controls the traffic and pedestrian signals.

Crosswalk - (a) That part of a roadway at an intersection included within the connections of the lateral lines of the sidewalks on opposite sides of the highway measured from the curbs or in the absence of curbs, from the edges of the traversable roadway, and in the absence of a sidewalk on one side of the roadway, the part of a roadway included within the extension of the lateral lines of the sidewalk at right angles to the centerline; (b) any portion of a roadway at an intersection or elsewhere distinctly indicated for pedestrian crossing by lines or other markings on the surface. (MUTCD)

Crosswalk lines – White pavement-marking lines that identify a crosswalk (MUTCD).

Curb radius – The radius of the edge of the pavement. Used to describe the sharpness of a corner. A large curb radius, which enables vehicles to go around corners faster, and gives long vehicles room to turn, results in a slowly curving curb line and curb ramps that are often angled toward the center of the intersection. In addition, the length of the crosswalk is increased. A small curb radius requires vehicles to turn more slowly.

Cycle length – Also referred to as cycle. The time required for one complete sequence of signal indications. (MUTCD) The cycle length includes the entire sequence of green, yellow, and red signal indications for each street at the intersection. For example, the time from one onset of vehicular green for East/West traffic until the onset of the next vehicular green for East/West traffic.

Dark mode – The lack of all signal indications at a signalized location. (MUTCD) The dark mode is most commonly associated with power failures.

Detector – A sensing device used for determining the presence or passage of vehicles or pedestrians. (MUTCD) When pedestrians and vehicles approach the intersection, the detector recognizes their presence and informs the signal controller.

Eight-phase operation – A signal cycle that is made up of eight distinct phases. Different phasing combinations can be developed to make up the eight phases, as part of actuated control.

Fixed-time operation – See pre-timed operation.

Flashing (Flashing Mode) – A mode of operation in which a traffic signal indication is turned on and off repetitively. (MUTCD)

Four-phase operation – A signal cycle that is made up of 4 distinct phases. Providing an exclusive left-turn phase for both streets can create a four-phase operation. For example, the 4 phases might be (1) left turns for N-S bound traffic, (2) through N-S bound traffic, (3) left turns for E-W bound traffic, and (4) through E-W bound traffic. The order of the phases varies, depending upon whether the left turning traffic goes before or after the straight through traffic.

Full-actuated operation – A type of traffic control signal operation in which all signal phases function on the basis of actuation. (MUTCD) Thus, the controller reacts to the detection of vehicles and pedestrians, changing the signals as needed to provide maximum efficiency in traffic movements.

Green interval – The time during a signal cycle when vehicles have a green ball (light) indication.

Inductive loops – A type of vehicle detector. These loops are typically formed by 12-guage or 14-guage wire placed in slots cut in the pavement. Once a vehicle has passed over or stopped on the wire, a change in the low current electrical flow communicates the presence of the vehicle to the controller unit.

Infrared detection – A type of vehicle or pedestrian detector. Infrared laser beams are sent to the pavement and reflected back. Vehicle presence and speed are determined by the time each beam is entered.

Interval – The part of a signal cycle during which signal indications do not change. (MUTCD) From the pedestrian's perspective the cycle contains three intervals (Walk, flashing Don't Walk and steady Don't Walk).

Interval sequence – The order of appearance of signal indications during successive intervals of a signal cycle. (MUTCD) For example, a green interval followed by a yellow interval followed by a red interval.

Island – A defined area between traffic lanes for control of vehicular movements and for pedestrian refuge. Within an intersection area, a median or an outer separation is considered to be an island. (MUTCD). Islands are usually raised slabs of concrete but can be areas that are just painted.

Leading Pedestrian Interval (LPI): A pedestrian WALK phase that begins before the green interval serving parallel traffic, rather than at the same time. Thus, pedestrians receive a WALK indication and can begin crossing a few seconds before vehicles in the street parallel to their direction of travel receive vehicular green

Leg – Another term for approach.

Magnetic detectors – Type of vehicle or pedestrian detection. A device imbedded in the pavement that functions similar to the inductive loops by using the earth's magnetic forces for detection.

Major street – The street normally carrying the higher volume of vehicular traffic. (MUTCD)

Median refuge - An area within an island or median that is intended for pedestrians to wait safely for an opportunity to continue crossing.

Microwave detectors – Type of vehicle or pedestrian detector. A sensor-mounted overhead that uses microwave beams aimed toward the roadways for detecting the presence of vehicles.

Minor street- The street normally carrying the lower volume of vehicular traffic. (MUTCD)

Multi-phase operation – A traffic signal operating on more than two phases.

Passive pedestrian detection – A feature that uses sensors (piezo-electric, infrared, microwave or video) to call or cancel the Walk interval; can also be used to extend the pedestrian clearance time.

Ped call – A request to the traffic signal controller for a pedestrian timing, initiated by a pedestrian pushing a pedestrian detector (pushbutton), or by passive pedestrian detection.

Pedestrian change interval – An interval during which the flashing UPRAISED HAND (symbolizing DON'T WALK) signal indication is displayed. When a verbal message is provided at an accessible pedestrian signal, the verbal message is "wait." (MUTCD)

Pedestrian clearance time – The time provided for a pedestrian crossing in a crosswalk, after leaving the curb or shoulder, to travel to the center of the farthest traveled lane or to a median. (MUTCD) Typically calculated for a walking speed of 4 feet per second, and typically indicated by a flashing upraised hand.

Pedestrian phase – The time provided for a pedestrian to initiate and complete crossing in a crosswalk. The pedestrian phase includes the Walk interval and the pedestrian change interval, when the flashing upright hand is displayed.

Pedestrian signal head (Pedhead) – A signal head, which contains the symbols WALKING PERSON (symbolizing WALK) and UPRAISED HAND (symbolizing DON'T WALK) that is installed to direct pedestrian traffic at a traffic control signal. (MUTCD)

Permissive mode – A mode of traffic control signal operation in which, when a CIRCULAR GREEN signal indication is displayed, left or right turns may be made after yielding to pedestrians and/or oncoming traffic. (MUTCD)

Phase – The right-of-way, yellow change, and red clearance intervals in a cycle that are assigned to an independent traffic movement or combination of movements. (MUTCD).

Piezo-electric – Type of pedestrian detection. Paving slabs, which consist of weight sensitive rubber cover a piezo cable located in the curbside area. The weight of the object on the paving slab sends an electric signal through the piezo cable confirming detection.

Platoon – A group of vehicles or pedestrians traveling together as a group, either voluntarily or involuntarily, because of traffic signal controls, geometries, or other factors. (MUTCD).

Pre-timed operation (Fixed-time) – A type of traffic control signal operation in which none of the signal phases function on the basis of actuation. (MUTCD). Thus, each roadway has a predetermined time for a green signal and each crosswalk has a predetermined time for the pedestrian phase. This time remains constant except the phases may be set for different lengths of times for different times of the day.

Protected mode – A mode of traffic control signal operation in which left or right turns may be made when a left or right GREEN ARROW signal indication is displayed. (MUTCD) For example, the turning traffic has the right of way when the green arrow is lit.

Pushbutton – A button to activate pedestrian timing. (MUTCD) Also known as a pedestrian detector.

Red clearance interval – An optional interval that follows a yellow change interval and precedes the next conflicting green interval. (MUTCD) All approaches have a circular red signal during this very short interval. It is sometimes referred to as "all-red interval".

Rest in Walk – The pedestrian signal head for crossing a minor street displays Walk and remains on Walk until a conflicting signal phase is called.

Right/left turn slip lane: A dedicated lane provided at an intersection for the free flow of vehicles turning right or left; may be uncontrolled or stop or yield controlled.

Right-of-Way – The permitting of vehicles and/or pedestrians to proceed in a lawful manner in preference to other vehicles or pedestrians by the display of signal indications. (MUTCD)

Roadway –Public right-of-way dedicated to vehicular traffic.

Scramble crossing – Another term for exclusive pedestrian phasing.

Semi-actuated operation – A type of traffic control signal operation in which at least one, but not all, signal phases function on the basis of actuation. (MUTCD)

Signal face – The front part of a signal head. (MUTCD)

Signal head – An assembly of one or more signal faces together with the associated signal housings. (MUTCD) There are signal heads for vehicles (display traffic signals) and pedestrians (display Walk and Don' t Walk signals).

Signal indication – The illumination of a signal lens or equivalent device. (MUTCD) For example, the circular green is a type of signal indication.

Signal phase – The right-of-way, yellow change, and red clearance intervals in a cycle that are assigned to an independent traffic movement or combination of movements. (MUTCD) Each movement within the cycle is referred to as a signal phase.

Signal timing – The amount of time allocated for the display of a signal indication. (MUTCD)

Signal warrant – A threshold condition that, if found to be satisfied as part of an engineering study, shall result in analysis of other traffic conditions or factors to determine whether a traffic control signal or other improvement is justified. (MUTCD)

Steady (steady mode) – The continuous illumination of a signal indication for the duration of an interval, signal phase, or consecutive signal phases. (MUTCD)

Three-phase operation – Adds a left-protection (phase) to the two-phase operation. For example, the phases would be (1) through traffic on N-S street, (2) through traffic on E-W street and (3) protected left turning traffic. The left turn phase can be before (lead left) or after (lag left) the through traffic.

Through movements - Vehicular or pedestrian traffic permitted to proceed straight through the intersection (without turning) during the designated signal phase.

Traffic control signal (traffic signal) – Any highway traffic signal by which traffic is alternately directed to stop and permitted to proceed. (MUTCD)

Two-phase operation – Each street at a signalized intersection receives one phase during which all movements, including pedestrian movements, are made.

Turn phasing – A phase involving a turn movement only.

Ultrasonic detection– Type of vehicle detection. Device sends ultrasonic waves to the pavement from an overhead mounted location. When a vehicle is in the detection zone, the ultrasonic wave is reflected off the vehicle and back to the controller device.

Video detection – Type of vehicle or pedestrian detection. A wide-area video image of the detection zone is captured from an overhead camera. Vehicles are detected as the light intensity of the image on the pictals changes in the detector zones. Once the vehicle is detected a message is sent to the traffic controller unit.

WALK interval – An interval during which the WALKING PERSON (symbolizing WALK) signal indication is displayed. When a verbal message is provided at an accessible pedestrian signal, the verbal message is "walk sign". (MUTCD) This interval is the time when pedestrians should leave the curb and start crossing the street.

Yellow change interval – The first interval following the green interval during which the yellow signal indication is displayed. (MUTCD)

Appendix D
Module 4
Glossary

MODULE 4 – APS Features: Description of Current Technology, Guidelines and Usage

GLOSSARY

Accessible Pedestrian Signal (APS) – A device that communicates information about pedestrian timing in non-visual format such as audible tones, verbal messages, and/or vibrating surfaces. (MUTCD) The primary function of an APS is to provide information about the Walk interval in a format that is accessible to pedestrians with visual impairments.

Actuation indicator – See Pushbutton actuation indicator.

Alert tone – A feature on a pushbutton-integrated APS that provides a brief burst of high frequency sound to alert pedestrians to the beginning of the Walk interval.

Audible beacon – A sound source that is used to provide the pedestrian with additional directional and alignment information for street crossings. A beacon is intended to help a pedestrian who is blind find the destination corner.

Automatic volume adjustment – A volume control feature on an APS that provides automatic response to ambient sound. Also called automatic gain control (AGC).

Button actuated timer (BAT) – A feature on APS that may activate the APS, additional information, or features after the pushbutton is pressed down for 1-3 seconds. This is one manufacturer's term; also called extended button press, extended push, and long button press.

Crosswalk map – A raised schematic map on a pushbutton APS device that shows what will be encountered as the pedestrian negotiates the crosswalk controlled by that push button.

Extended push – A feature on an APS that may activate additional information after the pushbutton is pressed down for 1-3 seconds. Also called BAT, extended button press, and long button press.

Locator tone – A repeating sound that informs approaching pedestrians that they are required to push a button to actuate pedestrian timing. This enables pedestrians who have visual disabilities to locate the pushbutton. Also referred to as locator signal or pushbutton locator tone.

Long button press – A feature on an APS that may activate additional information after the pushbutton is pressed and held down for 1-3 seconds. Also called BAT, extended button press, and extended push feature.

Professional Traffic Operation Engineer (PTOE) – A licensed professional engineer who holds specialized expertise and certification in traffic operations.

Pushbutton actuation Indicators, such as a light, a tone, a voice message, or both audible and visual cue, that signify to pedestrians that the pushbutton has been pressed.

Pushbutton information message – A speech message, which may provide additional intersection information, when the pedestrian pushes the pushbutton on a pushbutton-integrated APS. An extended button press may be required to activate the message.

Pushbutton locator tone– A repeating sound that informs approaching pedestrians that they are required to push a button to actuate pedestrian timing and that enables pedestrians who have visual disabilities to locate the pushbutton. (MUTCD)

Remote activation – A handheld remote feature that allows the pedestrian to send a message over a short distance to the controller to call the pedestrian phase.

Signal Technician – A person who works under the direction of traffic engineers. Installing APS hardware may be one responsibility of a signal technician.

Tactile arrow – A raised arrow on an APS that helps pedestrians know which crosswalk is actuated by the pushbutton.

Tactile map – A raised schematic map that shows what will be encountered as the pedestrian negotiates the crosswalk controlled by that push button. This is the same as crosswalk map.

Traffic Engineer –Professional engineer who works in traffic operations. One of the primary roles of traffic engineers is to conduct field studies and to make decisions regarding signalization and other factors influencing traffic conditions.

Vibrotactile Pedestrian Device – A device that communicates, by touch, information about pedestrian timing using a vibrating surface. (MUTCD) The pushbutton vibrates when the WALK signal is lit.